REPORT

TURKISH NATIONAL MRV SYSTEM DESIGN

VERSION 1.1

Prepared by
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Gold Standard

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CONTENTS

GLOSSARY AND ABBREVIATIONS

A/R	Afforestation / Reforestation
ACR	American Carbon Registry Standard
AGB	Above Ground Biomass (carbon pool)
Baseline	Forest management and GHG scenario that would occur in the absence of a project / intervention. Net difference in GHG balance between baseline and project scenarios is the benefit of a project / intervention.
BEF	Biomass Expansion Factor
BGB	Below Ground Biomass (carbon pool)
Carbon pool	A reservoir of carbon. A system which has the capacity to accumulate or release carbon
Carbon sink	Any process or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. A given pool (reservoir) can be a sink for atmospheric carbon if, during a given time interval, more carbon is flowing into it than is flowing out.
Carbon stock	Absolute quantity of carbon held within a pool at a specified time
CDM	Clean Development Mechanism
DW	Deadwood (carbon pool)
DSS	Decision Support System
ER	Extension of Rotation Age (IFM activity type)
FM	Forest management
GDF	General Directorate of Forestry
GHG	Greenhouse gas
GIS	Geographic Information System
GS	The Gold Standard Foundation
HWP	Harvested Wood Products (carbon pool)
IFM	Improved Forest Management
IPCC	Intergovernmental Panel on Climate Change
LI	Litter (carbon pool)
LUF	Land use and forestry
LULUCF	Land Use, Land Use Change and Forests
MRV	Monitoring, reporting and verification system
NIR	National Inventory Report Submission (to UNFCCC)
PF	Prevention of Fires and Pests (IFM activity type)
Project	Intervention (forest management activity) that changes GHG balance against the baseline scenario
RE	Rehabilitation (IFM activity type)
REDD(+)	Reducing Emissions from Deforestation and Forest Degradation
RI	Reduced Impact Operations (IFM activity type)
SDG	UN Sustainable Development Goals
Sequestration	The process of increasing the carbon content (uptake) of a carbon pool other than the atmosphere.
SL	Stop Logging (IFM activity type)
SOC	Soil Organic Carbon (carbon pool)
SOP	Inventory Standard Operating Procedures
tCO_2	Tons of CO_2
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard

FIGURES AND TABLES

MRV DESIGN: OBJECTIVES, APPROACH AND OUTLOOK

OBJECTIVES AND SCOPE:

This design document aspires to

- establish a quality and content framework to create a basis for the subsequent implementation of an MRV system,
- assess the current reporting and data environment for forest carbon MRV in Turkish Mediterranean Forests,
- provide good practice examples and methodologies for carbon quantification and activity impact modeling.

In the course of the project and in light of international agreements reached, the scope was extended to

- introduce a sustainability monitoring approach using indicators linked to the UN Sustainable Development Goals (SDGs),
- link the MRV system as an "add-on" to the newly started GDF/UNDP project developing a Decision Support System (DSS) for Turkish forest lands, thus creating synergies especially in data acquisition, management and modeling.

APPROACH AND CHALLENGES:

The philosophy behind this MRV design is that a good system has to a) use existing data sources and processes where possible (to not disrupt functional reporting channels) and b) create more than just a national carbon accounting system. Sustainable benefit is created when the data collected and reports produced also support decision makers in their day-to-day management and sustainability beyond traditional forest management becomes part of the planning process.

Thus, the design process was initiated with a set of workshops involving stakeholders from GDF to collect their expectations from an MRV system and to communicate the MRV architecture and objectives. Based on the inputs, the architecture was shaped and a national framework (part I of this document) established.

The next phase saw the challenge of data collection and the hunt for technical feedback to understand the current Turkish data environment. Based on the information and data received, part II of the design document was composed, resulting in an MRV design specification with enough flexibility (and some data gaps) to allow the DSS developers room for innovation. A standard operating procedure, technical guidelines and field protocols were developed in part III to close identified gaps in source data and calculation for all forest carbon pools. Upcoming testing the MRV concept and approach on the ground will provide valuable inputs for the implementation of the MRV system.

OUTLOOK AND EXPECTED RESULTS:

At this point, the project will enter a collaborative mode. With the MRV design document ready in Version 1.0, stakeholders will provide further inputs and the DSS team can start shaping the MRV "engine". With DSS moving towards innovative modeling approaches (e.g. growth and management models for forests and a cloud based infrastructure) and implementation, it will provide an ideal basis for carbon calculation and activity impact reporting in a challenging data environment.

INTRODUCTION

This *national Carbon Monitoring, Reporting and Verification (MRV) system design* report is the first step in the development of an MRV system for forests in Turkey in the **project stream** *Initial development and deployment of MRV for Turkey's Mediterranean forests* within the UNDP **project** *PIMS 4434 - Integrated approach to management of forests in Turkey, with demonstration in high conservation value forests in the Mediterranean region*.

Such an MRV system will enable Turkey to improve existing capacity not only for carbon reporting to UNFCCC/Paris or any other international agreement but also for preparing landscape level forest management plans with special criteria and indicators for climate change and contribution to the Sustainable Development Goals (SDGs).

This design report for a Turkish forest MRV system provides the guidelines and requirements for the implementation of an operational MRV tailored for Turkish Mediterranean forests and its activities demonstrating multiple environmental benefits by showing direct impact on Sustainable Development Goals (SDGs). Implementation of this MRV system is not part of this project but is included in the linked UNDP project "Decision Support System" implemented by Yale University. Figure 0-1 visualizes the MRV system development approach and its key elements.

Figure 0-1: MRV development approach and documentation levels

This report focuses on the key elements of the Turkish MRV system (compare green elements in Figure 0-1) and is structured as follows:

- Part 1: National MRV concept sets the framework and provides the principles for a national MRV system with a special focus on Sustainable Development Goals (SDGs).
- Part II: Forest MRV plan with carbon approach tailored for Turkish Mediterranean forests. Part II describes the current data situation in Turkey including carbon approaches and methodologies currently applied. It defines the way forward in data collection and management approach with focus on reporting systems for quick access to carbon information.
- Part III: MRV tools including technical guidelines. Part III presents the technical guidelines (i.e. measurement techniques, data collection, field protocols, etc.) developed for the Turkish MRV system.

PART I: NATIONAL MRV CONCEPT

The national MRV concept sets the framework and provides the principles for a national MRV system with a special focus on Sustainable Development Goals (SDGs)[1]. It list best practice for MRV and is in line with requirements collected in the two days scope setting workshop with GDF and its stakeholders conducted in Ankara on February 17/18, 2016.

This part is structured in 5 sections:

- **Section A: Scope and Activities** describes the general accounting approach, forestry activities to be monitored and relevant GHG pools.
- **Section B: MRV Requirements** summarizes GHG governance functions and their requirements for the MRV system.
- **Section C: MRV Architecture** describes the technical layers of an MRV system
- **Section D: Baseline & Carbon Conversion** introduces baseline approaches (reference values for GHG benefit calculations) and the procedures to calculate CO_2 impact
- **Section E: SDG Monitoring** contains the Gold Standard proposal for SDG indicators and monitoring approach

[1] Note that part I is a general approach while part II is more specific to the specific Turkish situation.

SECTION A: SCOPE AND ACTIVITIES

A.1 INTRODUCTION

A.1.1 LAND VERSUS ACTIVITY BASED APPROACHES

Generally two different options are available to estimate GHG emissions: The land based approach proceeds from the classification of all the managed territory of a country into the IPCC land categories. Emissions and removals are calculated on the basis of this classification and may be due to management practices on the land remaining in the same category, or due to changes from one category to another (such as conversion from forest to cropland, or vice versa).

The activity-based approach proceeds from identifying specific activities occurring on the land that influence GHG fluxes. This approach focuses on the anthropogenic intervention and allows differentiation between activities. This approach can capture changes which would not be identified in the land based approach e.g. a degraded forest which is restored (stock increase trough planting) remains forest in the land based approach (no change is captured) while the activity based approach captures the stock increase by measuring the carbon stock in the respective pools.

The national MRV system for Turkish Mediterranean forest is intended to report GHG net emissions and also support decisions regarding forest activities. Activity based calculations are thus essential to indicate consequences of land use scenarios (i.e. planned activities) regarding their impact on biomass and carbon stocks, as well as socioeconomic and environmental factors.

The following chapters provide an overview of forest activities, pools and GHGs for the National MRV concept.

A.1.2 ACTIVITIES

For the 1st commitment period (2008-2012) of the Kyoto protocol the only mandatory and eligible forest activity was A/R, (with the exception of limited additional voluntary activities), while for the 2nd commitment period (2013-2020) forest management became mandatory as well. The recent Paris agreement includes now all REDD+ activities, specifically addressing forest conservation and restoration as crucial strategies to cut worldwide emissions. REDD+ is the acronym for “Reducing emissions from deforestation and forest degradation in developing countries”; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developed countries. The scope of REDD+ activities currently includes the following activities:

- Reducing emissions from deforestation;
- Reducing emissions from forest degradation;
- Conservation of forest carbon stocks;
- Sustainable management of forests;
- Enhancement of forest carbon stocks

For Turkey the following forest activity categories play a key role: afforestation/reforestation A/R (planting of trees on land that does not meet the forest definition at planting start), IFM (managed forest that will continue to be managed and timber may be harvested in a sustainable manner – this category also includes forest restoration) and conservation (planning and maintaining forests for the benefit and sustainability of future generation while no harvesting is allowed).

A.1.3 POOLS

Forest activities have an impact on specific carbon pools such as above-ground biomass (AGB), below-ground biomass (BGB), litter (LI), dead wood (DW), soil organic carbon (SOC) and harvested wood products (HWP) and thus all changes within these pools caused by an activity need to be monitored. All major carbon standards (CDM, Gold Standard, VCS, etc.) and also national programmers (FCPF, UNFCCC, etc.) allow the omission of a pool for a specific activity if transparent and verifiable information is provided that demonstrates that the pool is insignificant. Definition and sources of above pools can be found in Table A.1-1 below.

Table A.1-1. Forest carbon pool definitions and sources

Term	Abbreviation	Source	Definition	Comments
Above Ground Biomass	AGB	IPCC 2006 GL FRA 2005	All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage. Also includes trees, shrubs, and herbaceous vegetation.	Where the forest understory is a relatively small component of the above-ground biomass, it is acceptable to exclude it, provided this is done in a consistent manner throughout the inventory time series.
Below Ground Biomass	BGB	IPCC 2006 GL FRA 2005	All living biomass of live roots. Fine roots of less than (suggested) 2mm diameter are sometimes excluded because these often cannot be distinguished empirically from soil organic matter or litter.	May include the below-ground part of the stump. Turkey may use another threshold value than 2 mm for fine roots, but in such a case the threshold value used must be documented.
Deadwood	DW	IPCC 2006 GL	Includes volume of all non-living wood not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country. Includes dead roots to usually 2mm diameter.	
Harvested Wood Products	HWP	IPCC good practice guidance (2003) VCS VMD0026 Version 1.0 VCS MODULE VMD002 6	include wood and paper products such as furniture, construction material, plywood, wood-based panels, and paper from harvested forests within the country	All standards and methodologies consider wood products with a lifetime longer than 100 years as permanently stored HWP does not include carbon in short-lived products, wood waste from production of long-lived products, harvested trees that are left at harvest sites or products made from imported wood
Litter	LI	IPCC, 2006	Includes all non-living biomass with a diameter less than a minimum diameter chosen by the country (for example 10 cm), lying dead, in various states of decomposition above the mineral or organic soil. This includes litter, fumic, and humic layers. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.	
Soil Organic Carbon	SOC	IPCC 2006	Organic carbon in mineral soils to a specific depth chosen also including live and dead fine roots within the soil	

A.1.4 GHG GASES

Land use and management influence a variety of ecosystem processes that affect greenhouse gas fluxes such as photosynthesis, respiration, decomposition, nitrification/denitrification, enteric fermentation, and combustion. These processes involve transformations of carbon and nitrogen that are driven by the biological (activity of microorganisms, plants, and animals) and physical processes (combustion, leaching, and run-off).

The key greenhouse gases of concern from forest activities are CO_2, N_2O and CH_4. CO_2 fluxes between the atmosphere and ecosystems are primarily controlled by uptake through plant photosynthesis and releases via respiration, decomposition and combustion of organic matter. N_2O is primarily emitted from ecosystems as a by-product of nitrification and denitrification, while CH_4 is emitted through methanogenesis under anaerobic conditions in soils and manure storage, through enteric fermentation, and during incomplete combustion while burning organic matter. [2]

Generally two approaches are possible: either all above listed GHGs are recorded per activity and pool (if applicable and significant), which requires significant efforts, or more pragmatically only CO_2 is recorded and defaults are deducted from overall carbon stock for every below listed activity if such techniques are used in a specific area [3]:

- Site preparation (burning of biomass: carbon stock =-10%)
- Nitrogen fertilizer: 0.005 tCO_2 per kg of nitrogen (N) fertilizer shall be deducted
- Emissions caused on N fixing species may be conservatively assumed to be zero
- Non CO_2 emissions caused by fossil fuel from project activities (flight, management, etc) assumed to be zero.

In the following, generally the latter more pragmatic approach is suggested, with the exception of IFM activity "avoided forest degradation through fire management" where CH_4 emissions are significant.

A.2 ACTIVITIES, POOLS & GHGS TO BE MONITORED IN THE FORESTRY MRV

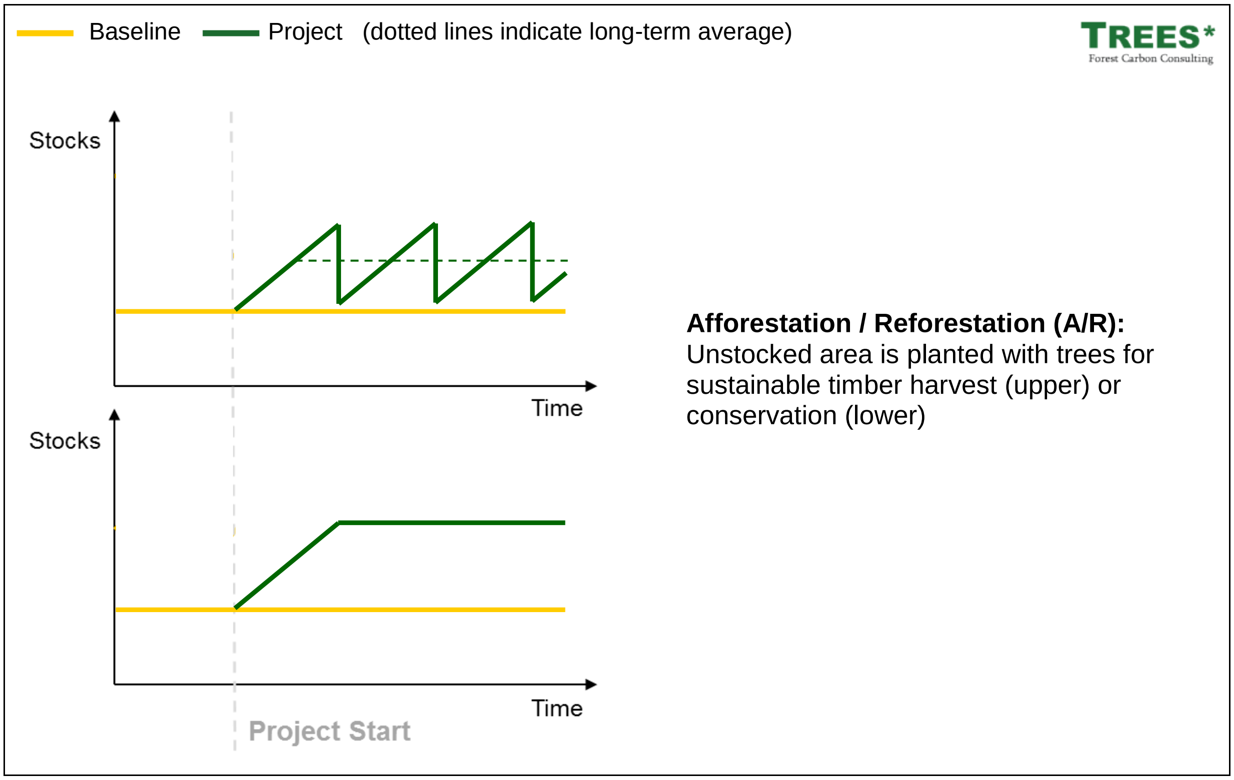
A.2.1 AFFORESTATION / REFORESTATION (A/R) ACTIVITIES

Afforestation / Reforestation activities have a non-forest, low stock baseline (e.g. degraded land). Stocks are subsequently increased by planting trees to create long-term forest cover. This commonly leads to a land use change (i.e. conversion of non-forest land to forest land). From a carbon's perspective only the long-term average stock is accounted for if forests are harvested and replanted again. Due to the growth/harvest cycle this is approximately 50% of the managed biomass.

[2] IPCC Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)

[3] Approach according to GS

Figure A.2-1: Baseline and project stock development for A/R activities



A.2.1.1 A/R Activities

Category	Activity
Timber harvest	• Plant trees to create a managed plantation (e.g. selective harvesting, rotation forestry)
	• Plant trees in agroforestry systems[4]
	• Plant trees in silvopastoral systems[3]
Conservation	• Create new forest (no harvest of timber)

[4] Agroforestry and silvopastoral schemes currently not officially applied in Turkey (according to Mithat Koç, Deputy Head of Forest Management and Planning Department, GDF). Thus these activities will not be further specified.

A.2.1.2 A/R Pools[5]

Carbon Pools	Baseline	Project
Above ground biomass (AGB)	Yes	Yes
Below ground biomass (BGB)	Yes	Yes
Dead wood (DW)	No	Yes
Litter (LI)	Yes	Yes
Harvested wood products (HWP)	No	Yes
Soil organic carbon (SOC)	Optional[6]	Optional

A.2.1.3 A/R Greenhouse Gases

Only the GHG CO_2 is recorded and monitored but the following defaults are deducted from resulting carbon stocks.

- Site preparation (burning of biomass: overall carbon stock-10%)
- Nitrogen fertilizer: 0.005 tCO2 per kg of nitrogen (N) fertilizer shall be deducted
- Emissions caused on N fixing species may be conservatively assumed to be zero
- Non CO2 emissions caused by fossil fuel from project activities (flight, management, etc,) assumed to be zero.

A.2.2 IMPROVED FOREST MANAGEMENT / SUSTAINABLE FOREST MANAGEMENT

Improved forest management activities take place in forest areas remaining forest (no land use change). Activities are changed to sustainably increase forest stocks, starting from a variety of baselines. The following figures visualize stock development for various forest management activities and baseline scenarios. Note that all activities listed provide an increase in carbon stocks and/or a reduction of emissions. However, if allowed without restrictions, some of the activities may lead to potentially degrading activities (e.g. “improved harvesting” on a previously intact forest or “extension of rotation age” in an area which is too remote to access with modern harvesting equipment).

[5] According to GS A/R Requirements
[6] In most cases SOC change will not be significant as existing pre-project vegetation (e.g. grass) also has a substantial SOC content. Exception to this might be afforestation/reforestation activities in desert areas.

Figure A.2-2: Baseline and project stock development for Reduced Impact Logging (RI) activities

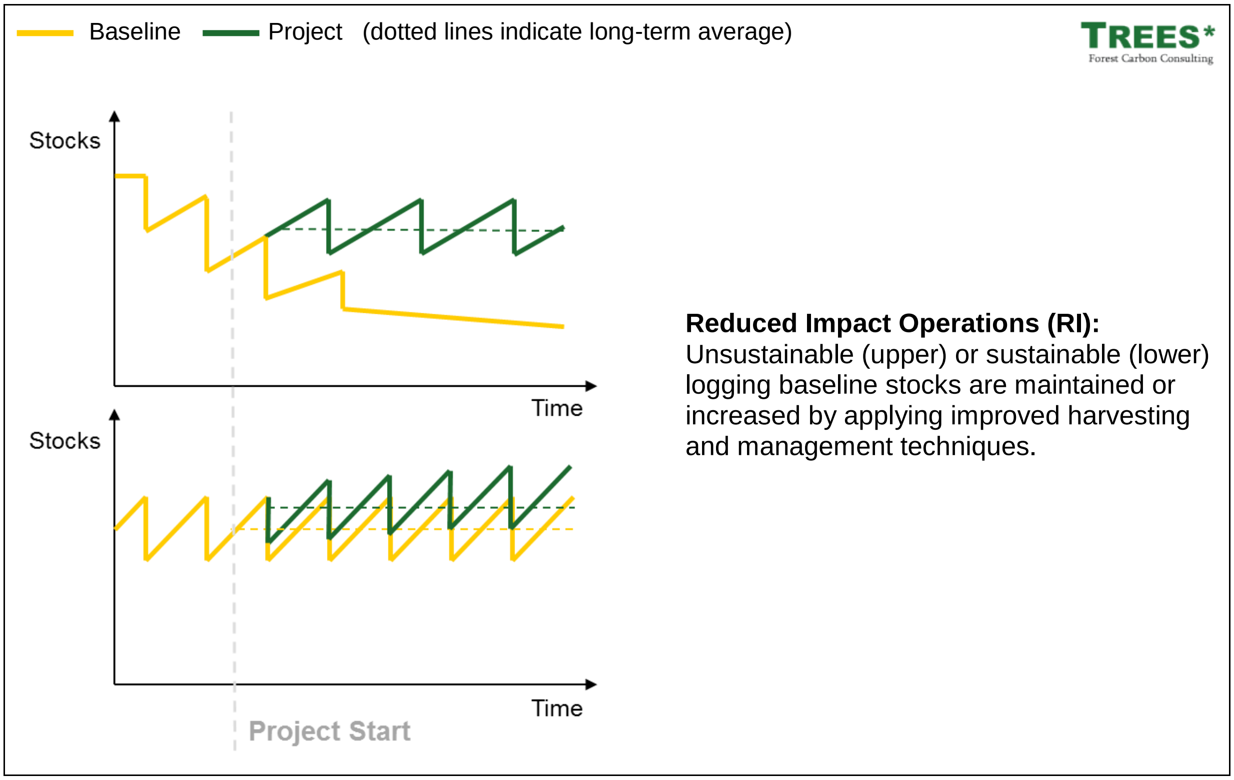


Figure A.2-3: Baseline and project stock development for Extension of Rotation Age (ER) activities

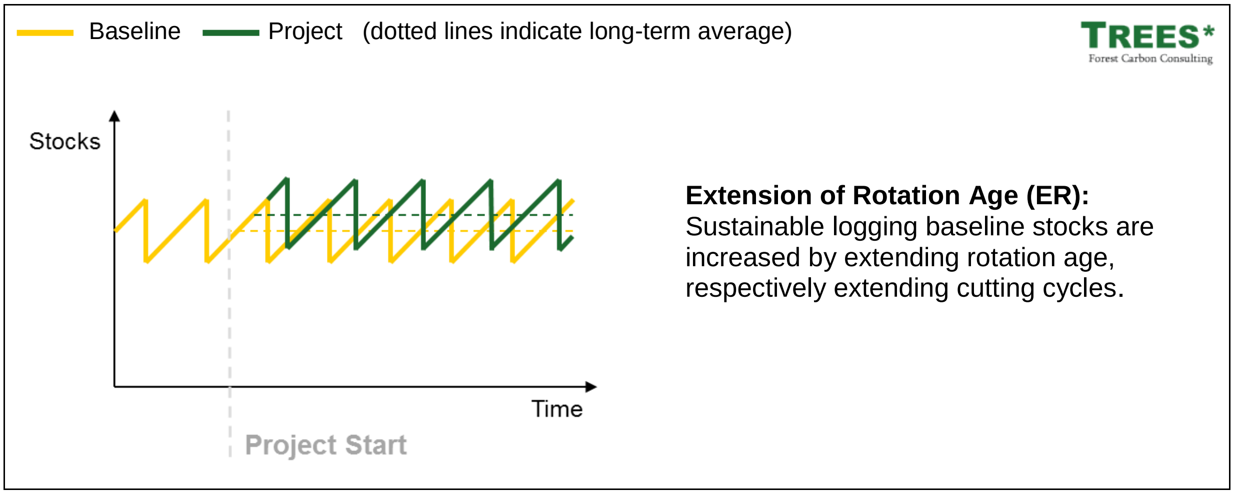


Figure A.2-4: Baseline and project stock development for Increased Growth Management (IG) activities

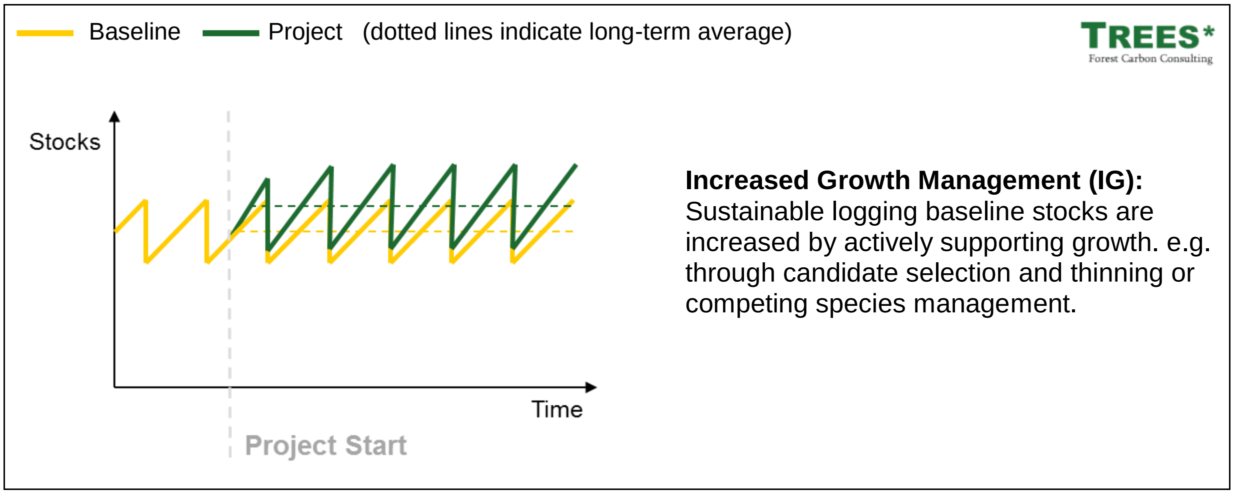


Figure A.2-5: Baseline and project stock development for Rehabilitation (RE) activities

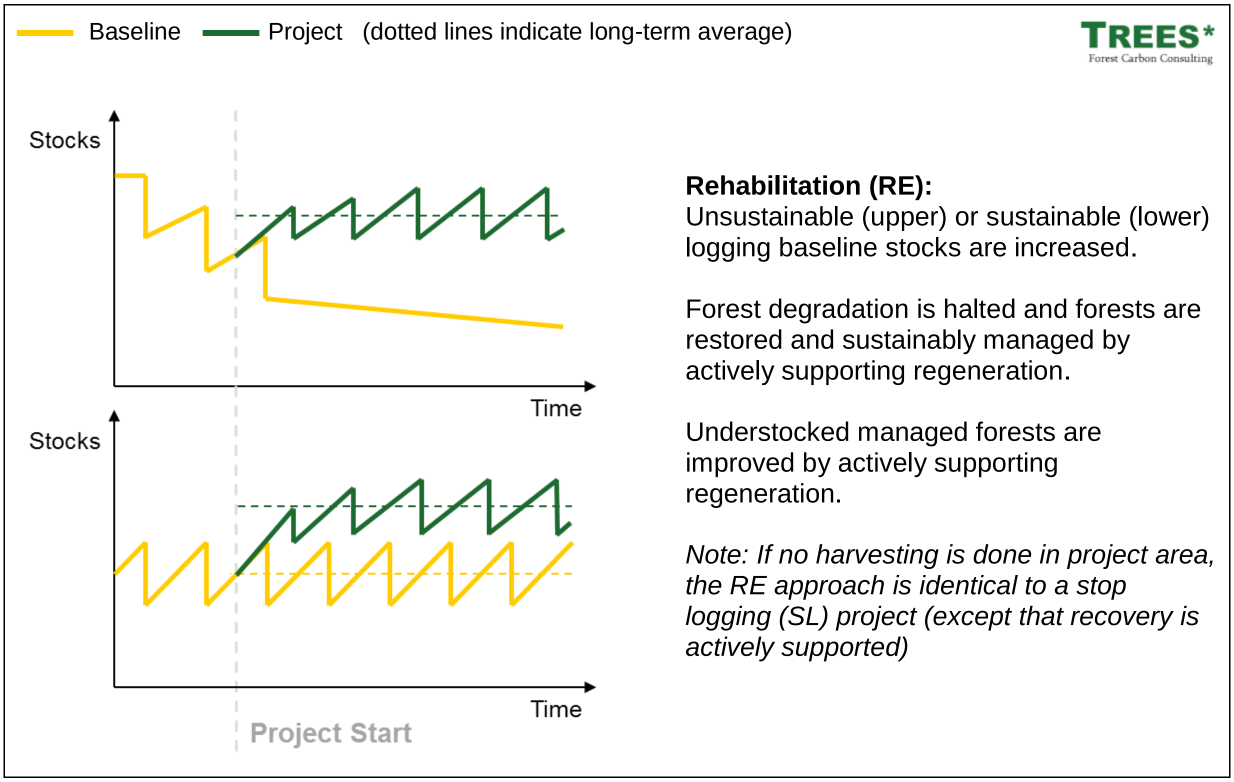
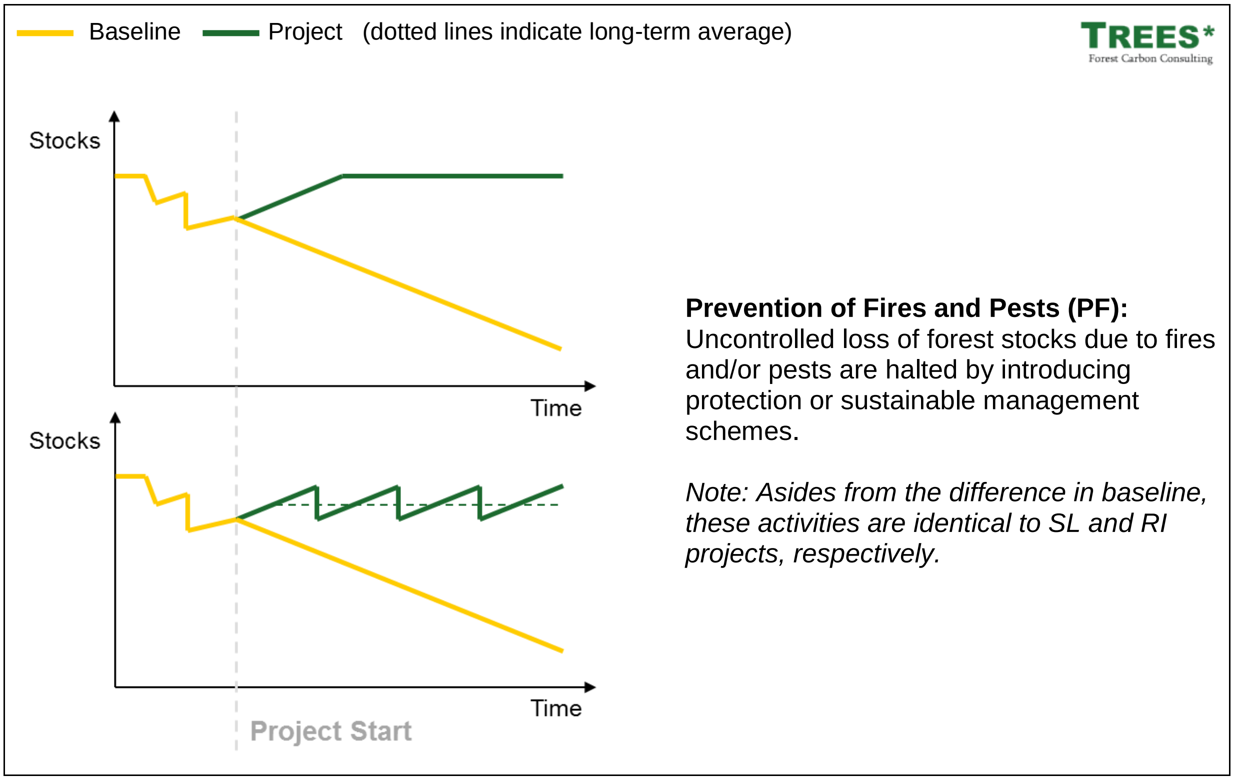


Figure A.2-6: Baseline and project stock development for Prevention of Fires and Pests (PF) activities



A.2.2.1 IFM Activities

Category	Activity
Prevent loss of stock	• Prevention of re-logging (before sustainable rotation/revisit)
	• Improving harvest techniques and processes to reduce impact
	• Avoided forest degradation through fire management
Increase stocks	• Extended rotation age or cutting cycle
	• Candidate selection and thinning to increase stand growth
	• Competing species management
	• Increase stock in degraded forests (restoration)
Increase HWP	• Increasing carbon stocks in harvested wood products
	• Shift from short-term to longer-term wood products

A.2.2.2 IFM Pools

Carbon Pools	Baseline	Project
AGB	Yes	Yes
BGB	No[7]	No
DW	Yes	Yes
LI	No	No
HWP	Yes	Yes
SOC	Optional[8]	Optional

A.2.2.3 IFM Greenhouse Gases

Only the GHG CO_2 is recorded and monitored but the following defaults are deducted from resulting carbon stocks.

- Site preparation (burning of biomass: overall carbon stock-10%)
- Non CO_2 emissions caused by fossil fuel from project activities (flight, management, vehicles, machinery etc) assumed to be zero.

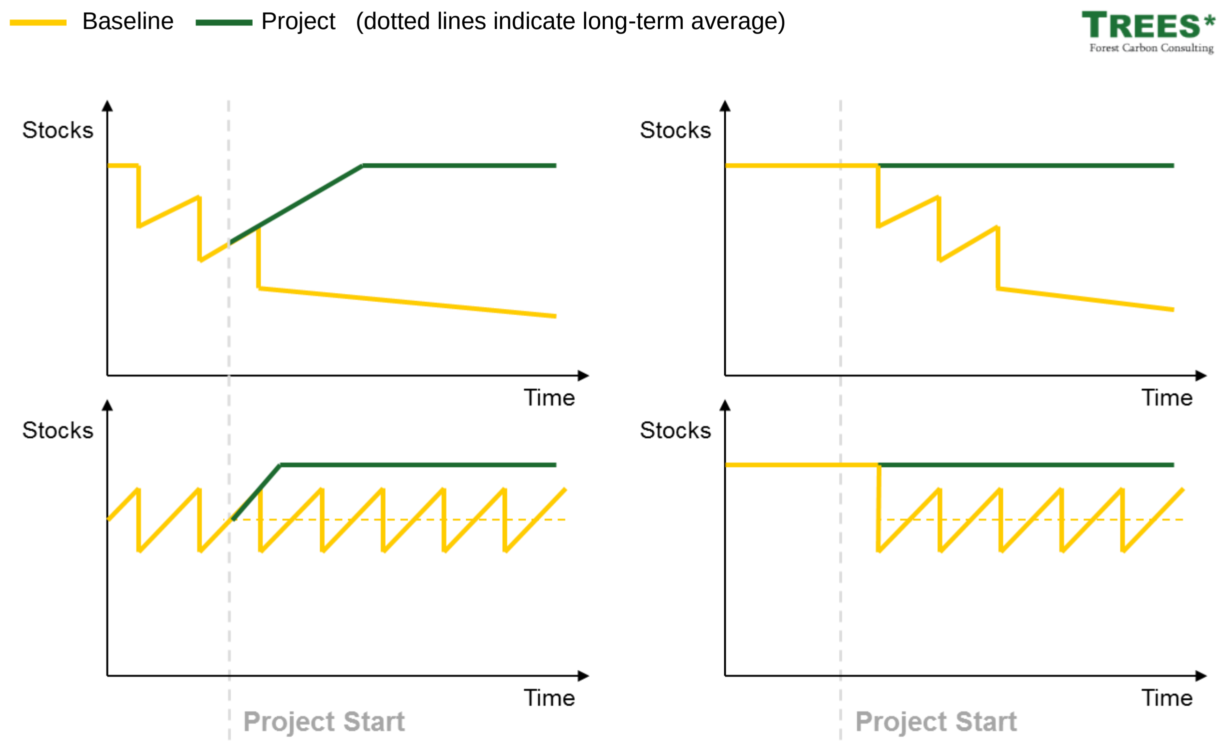
Exception to above approach is IFM activity "Avoided forest degradation through fire management". As CH_4 emissions from burning forests are considerable, these emissions must be calculated based on actual biomass lost instead of applying the default deduction for burning of biomass)

A.2.3 CONSERVATION

Conservation activities take place in forest areas remaining forest (no land use change). Activities are changed to maintain forest stock or increase forest stocks, starting from a variety of baselines. Conservation activities can be considered IFM activities without subsequent harvesting. A key example for this are IFM Stop Logging activities where current or planned harvesting activities are prevented to conserve (and improve) the existing stands.

[7] For increase stock activities Yes both in baseline and project
[8] SOC is only recommended for activities increasing forest stock due to restoration of degraded forests. For all other IFM activities no significant SOC change is expected.

Figure A.2-7: Baseline and project stock development for Stop Logging (SL) conservation activities



Stop Logging (SL): Unsustainable (upper) or sustainable (lower) logging baseline (active (left) or planned (right) at project start) is prevented for forest stocks to recover, respectively remain.

A.2.3.1 Conservation Activities

Category	Activity
Conservation	• Stop logging in managed forests; eliminating timber harvesting (harvesting for conservation allowed)[9]
	• Prevention of harvest in untouched forests[10]
Restoration	• Restoration for conservation (Rehabilitation of logged forests, increase stocks in understocked areas, "enrichment planting" for conservation only, no subsequent logging)

[9] Stop logging projects are handled under IFM rules by most carbon standards.

[10] Protection of untouched forests is an IFM category or REDD category if leads to deforestation, with modeled scenario(s) as baseline.

A.2.3.2 Conservation Pools

Carbon Pools	Baseline	Project
AGB	Yes	Yes
BGB	No	No
DW	Yes	Yes
LI	No	No
HWP	Yes for stop logging (not for untouched)	No
SOC	Optional[11]	Optional

A.2.3.3 Conservation Greenhouse Gases

Only the GHG CO_2 is recorded and monitored but the following defaults are deducted from resulting carbon stocks.

- Site preparation (burning of biomass: overall carbon stock-10%)
- Non CO_2 emissions caused by fossil fuel from project activities (flight, management, vehicles, machinery etc) assumed to be zero.

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[11] SOC is only recommended for activities increasing forest stock. For protection of existing forests no significant SOC change is expected.

A.3 SDG TO BE MONITORED IN THE FORESTRY MRV

For the forest activities listed above, the MRV system is to monitor not only impacts on carbon pools and forest stocks but also impacts / trade-offs for other forest functions (especially biodiversity, socioeconomic impacts, health, fire, etc.). UN countries have agreed on a set of 17 Sustainable Development Goals (SDGs) covering a very broad view on social, economic and environmental sustainability (Figure A.3-1)

Figure A.3-1 United Nations Sustainable Development Goals (SDGs)

Forests and land use impact almost all of the SDGs either directly or indirectly. For a practical MRV system however, monitoring efforts should be focused on the most impacted SDGs. A Gold Standard report on tracking SDG impact of carbon projects proposes to quantify impacts on SDG 1 (No poverty), SDG 6 (Clean water and sanitation), SDG 8 (Good jobs and economic growth) and SDG 15 (Life on land). The report does not include SDG 13 (Protect the planet) which addresses climate change, because it is intended as an add-on to carbon projects already focusing on greenhouse gas benefits.

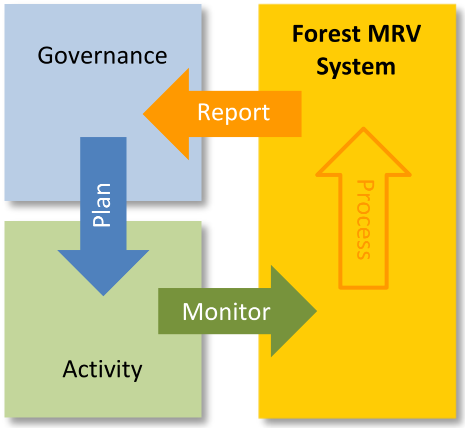
The full Gold Standard report introducing a monitoring system to assess impact of forest management activities on sustainable development is attached to this MRV concept in Section E:.

SECTION B: MRV REQUIREMENTS

B.1 INTRODUCTION

A basic forest MRV system is a tool to report activities and their impact on GHG balance (net emission or sequestration). As such, it is also a management tool to support governance and policy decision to improve said balance for forestry activities. As it is based on activity data, it also indicates governance issues and efficiency of policy implementation (cf. Figure B.1-1).

Figure B.1-1 The forest MRV system in the context of governance and operational activities



Performance and content of an MRV system depend on specific requirements which relate to the governance functions and objectives linked to the system. For the Turkish forestry MRV system, a series of governance functions and activities have been identified revolving around forest management practices and their impacts on greenhouse gases as well as other economic, social and environmental aspects.

The tables below indicate information need for each governance function and the underlying data and models. The information needs will essentially define the requirements for the reporting functionality of the MRV system while the data and model requirements are the basis for the data input, management and processing functionality.

B.2 GOVERANCE FUNCTIONS AND REQUIREMENTS

Requirements for monitoring and reporting are generally driven by needs for governance. The information needed to meet governance objectives defines the data and processing required. Table B.2-1 (below) lists key governance functions and their requirements.

Table B.2-1: Governance functions and MRV requirements

Governance function and objectives	Governance elements	Associated information	Data and model requirements
Forestry operations management: Achieve transparency on status of forest stands, risks and activities to decide on measures to be taken.	Forest status and risks	• Forest types, location and size	• Forest maps ○ Boundaries ○ Forest types ○ Stand areas
		• Forest environment	• Forest environment maps ○ Climate zones ○ Soil types, degradation ○ Hydrology (e.g water stress)
		• Structure and volumes ○ Stand properties ○ Current stocks ○ Stock changes / increments	• Tree stand information: ○ Species ○ DBH and height ○ Age (for plantations) ○ Health status • Volume models (commercial volume, total volume) • Historic data and change calculations
		• Loss risks due to ○ Fire ○ Pests (insects and diseases) ○ Unplanned human activities (e.g. illegal harvest) ○ Natural catastrophes and climate change	• Fire[12] : ○ historic fire events ○ fire probability ○ expected impact • Pests[11]: ○ historic pest events ○ exposure (stress indicators) • Unplanned activities: ○ historic anthropogenic events

[12] Data requirements for fire and pests are indicative only. Complex models may require additional input parameters. This is to be specified in the Level 2 MRV Plan, in alignment with existing fire risk models.

			○ local population's dependency (firewood need, non-timber products, agricultural dynamics, regional development) • Natural catastrophes: ○ historic natural loss events ○ exposure (water proximity, slope, geology, climate and weather models) ○ expected change in precipitation, winds, temperature • Risk models or maps (for all of the above)
	Silvicultural activities	• Activities completed • Planned activities • Expected impact of activities	• Silvicultural activity reports ○ Location ○ Activity performed ○ Impact (harvest volume, additional losses) • Silvicultural plans ○ Planned locations ○ Planned activities ○ Planned impact (on volume, structure, species)
	Expected development	• Expected forest change (various activity scenarios)	• Growth models • Activity and risk impact models
Greenhouse gas reporting and management: Enable quantification of GHG impact of change in forest areas (including land use change as well as management effects in forests remaining forest).	UNFCCC/Kyoto Protocol National GHG Inventory Reporting[13]	• GHG emissions balance from forestry activities, including land use change (afforestation, reforestation, deforestation) and forest management	• GHG balance from land use change (afforestation, deforestation) ○ Area per land use category ○ Change of area per land use category (from previous report) ○ Activity emissions from land use change ○ Stock change from land use change for all relevant carbon pools • GHG balance from forest management ○ Areas under each management type ○ Change of areas under each management type (from previous report) ○ Emissions from forestry activities ○ Stock change from forest management change for all relevant forest carbon pools

[13] National reporting requirements for Paris Agreement are not yet specified. It can be assumed that it will be a combination of (activity-based) GHG reporting similar to the UNFCCC/Kyoto reports combined with sustainability indicators (see below)

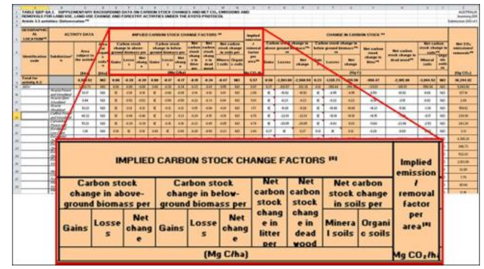
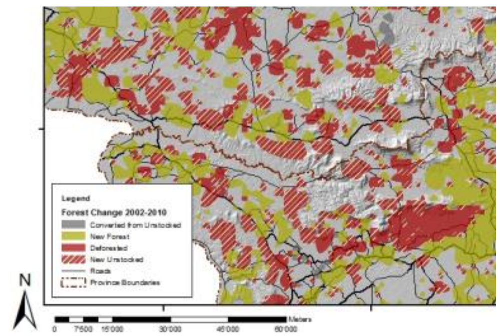
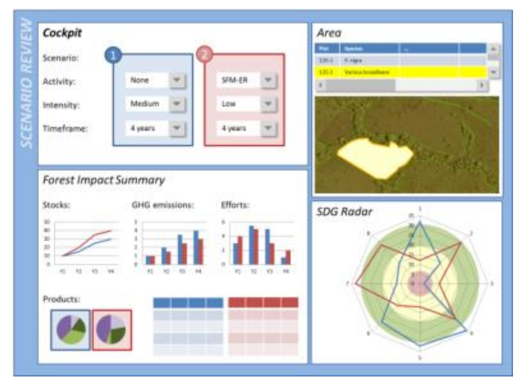
	Subnational impact of forestry activities on GHG balance	• GHG emissions balance from all forest activities for specific forest area and type	• Emission factors for forestry activities for a specific forest area o Emissions from forestry activities o Stocks under each forestry activity o Stock change from land use change or management change for all relevant forest carbon pools • Baseline and scenario models for different activities
Sustainable development: Enable quantification of impact of activities in forest areas on sustainable development goals (SDG).	National SDG reporting	• SDG impacts of forestry activities	• Area per forest activity • Impact of forest activity per SDG (according to indicators listed in Gold Standard SDG Monitoring Approach (see Section E:)
	Subnational impact of forestry activities on SDGs	• Effect on relevant SDGs from all forest activities for specific forest area and type	• Impact of all forestry activities on each SDG according to indicators listed in Gold Standard SDG Monitoring Approach (see Section E:) • Baseline and scenario models for different activities

B.3 REPORT TYPES

Generation and formatting of reports can take up considerable part of the overall MRV efforts, so a diligent design and planning for all reports is essential to an efficient and effective MRV system.

While reporting content is generally driven by the governance function as described above, format will largely depend on what the information is used for, respectively how it is to be spread (e.g. management decisions, basis for technical analysis, input for other reports, direct publication, etc.). Table B.3-1 below indicates typical report types, their usage and a format example. In the MRV architecture, the outputs and reports will be matched to these report types.

Table B.3-1: Typical MRV report types

Typical MRV Report Types	Usage	Format example (indicative only)
Data table	• Consolidation into higher-level reports (e.g. UNFCCC reports) • Data analysis, research • Further processing (in other systems)	
Map (GIS data)	• Communication, publication • Spatial data analysis and consolidation • Spatial modeling • Change visualization (historic or prospective) • Land use management	
Cockpit report	• Policy or management reporting ("at-a-glance reports") • Scenario impact modeling (comparison of activity options) • Change visualization (indicator based) • Decision support	

B.4 DATA SOURCE AND MODEL REQUIREMENTS

An MRV system's quality is driven the by the underlying data and models. And while a lot of focus often goes towards well-structured and nice-looking reports, key to a good system is getting the right data, and getting it sustainably. The MRV system also needs to be able to accommodate changes in data sources and data structure. A generally applicable set of requirements for data sources, handling and processing thus helps ensure that the quality of the MRV system is maintained over time:

General data quality requirements: Data used in MRV system must be…

- locally applicable for the envisaged purpose (with proof of applicability)
- accurate, with known uncertainty[14]
- conservative (i.e. rather underestimating positive and overestimating negative effects), especially if uncertainty is high or unknown
- regularly updated at a frequency that fits the type of data and source

General data source requirements: Data used in MRV system must be from sources that are…

- official, specific and up-to-date
- publicly available or with verified long-term access
- peer-reviewed (for scientific data) and with identified authorship and responsibility
- consistent over time (content, quality and accessibility)

General processing requirements: Processing functions in MRV system must be…

- transparent, i.e. with documented calculations and parametrization
- traceable and reproducible
- allow comparison with alternate models or data (e.g. for model or data transition)
- built in a modular architecture to allow changes to individual functions or models over time (without having to rebuild major parts of the processing layer)

[14] Uncertainty for input data depends on source and quality. For a specific carbon calculation approach (i.e. net GHG balance), Gold Standard allows a maximum error of the mean of ± 20% at a 90% confidence interval.

Data-related system requirements: The MRV system must be…

- able to align new data sources with historic data (e.g. through parallel data use or retrospective modelling to identify potential bias). This is to ensure that changes can be reported seamlessly, even if a data source (e.g. satellite or database) is discontinued or replaced.
- flexible/adaptable to accommodate change in data structure or format (i.e. efficiently manageable and customizable data interfaces). Changes of measurement approach, processing or format of imported data (at the source or in the interface) can thus be handled quickly, ensuring continued data availability.

SECTION C: MRV ARCHITECTURE

C.1 INTRODUCTION

The greenhouse gas MRV (monitoring, reporting and verification) system to be developed is serving multiple purposes for a variety of stakeholders, requiring different outputs and processing of data from various sources. The basic technical MRV architecture described in this document will serve as a point of reference for design and development of the respective MRV elements. It also provides the framework for technical specification of data, processing and reporting functions.

Note that the architecture may include elements that will not be developed in this project but are described to indicate potential future MRV system add-ons or links to external systems.

The descriptions and specifications provided in this document may be changed due to factors encountered during further development, e.g. changes in reporting needs, data availability or development efforts (cost/benefit considerations).

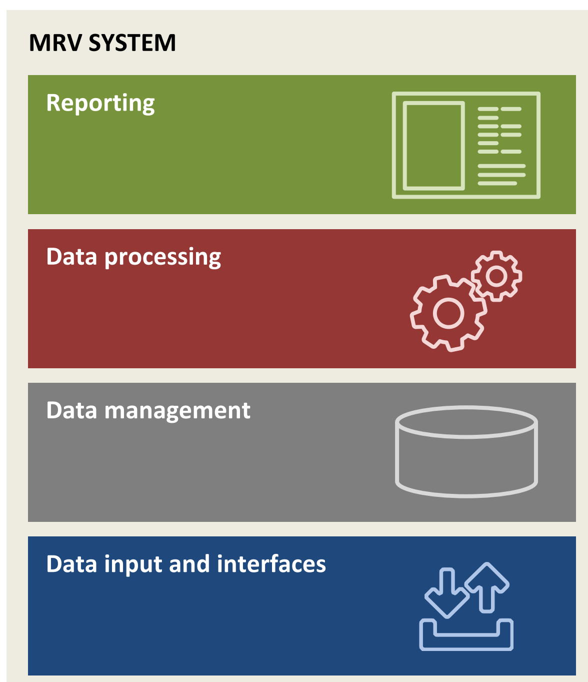
C.2 MRV STRUCTURE

The technical MRV system is structured in four **functional layers** (Fig. C.2-1).

The **reporting layer** contains the information output functions which are the core deliverable of an MRV system. This layer is the most visible and is customized to meet the MRV stakeholders' needs. Consequently, it also determines the data content and processing required in the lower MRV levels.

To generate information for the reports, a **data processing layer** is essential. This layer encompasses the functions needed to transform the base data into the structured output and indicators listed in the reports. The functions can range from simple calculations (e.g. multiplying a base data element with a set of parameters to create the target information) to complex, cross-data analysis and statistical modelling (e.g. to indicate dependencies or causality, create scenario maps or run forecast models). The data processing layer can contain standard elements (e.g.

Figure C.2-1: *MRV functional layers*



calculation rules for greenhouse gas accounting) as well as highly customized functionality (e.g. a map showing forest stock loss risks based on a localized empiric analysis). This layer is thus one of the key cost and effort drivers of an MRV system, requiring thorough analysis and prioritization of functions to be included.

The **data management layer** is providing the data required for processing and reporting. It serves as a data warehouse, combining data storage and handling functionalities with data quality assurance for input data and parameters, as well as results returned from the processing layer.

Strongly linked and related to data management is the **data input and interfaces layer**. It describes the data flows in and out of the MRV system. It specifies technical interfaces to external systems, other data feeds (e.g. data sets which are collected, formatted or consolidated, and then loaded into the MRV system), as well as potential manual direct entry functions for the MRV system.

Each of the above elements will be further specified in the following sections.

C.3 REPORTING LAYER

In this section the general purpose, key contents and structure (report type, see paragraph B.3) is specified for each report. Note that not all of the reports listed below are mandatory for a Forestry MRV system. From a reporting perspective, a national GHG inventory table based on reliable data might be fully sufficient. However, active GHG emissions and sequestration management requires – besides the accounting perspective – an understanding of forest management activities and potential risks (on an operational level), high-resolution spatial information (GHG “hotspots”), and scenario views as a decision support for GHG and forest management activities.

The reporting elements listed below will be specified in more detail and with reference to the Turkish Mediterranean situation in the MRV Level 2 specification. Where possible, the MRV reporting layer will be embedded/linked with the DSS (Decision Support System) currently being set up in a separate project stream (lead by Prof. Chard Oliver of Yale School of Forestry & Environmental Studies), which may require adaptations to this architecture.

C.3.1 GREENHOUSE GAS REPORTS

C.3.1.1 National GHG Inventory Report Table

Purpose: National GHG Inventory data for forestry, to be integrated in international reporting processes (e.g. UNFCCC LULUCF sector report, future reporting under the Paris agreement)

Contents: Carbon stocks in forests (including all carbon pools), activity-based emission and sequestration, including forest management impact and land-use change.

Structure: Data table

C.3.1.2 Subnational GHG Report

Purpose: Subnational reports are used to track specific activities' impact on carbon stocks and GHG emissions or to document a specific operational unit's GHG balance (e.g. to show regional differences).

Contents: Carbon Stocks per area, activity-based sequestration and emissions per area (stock change), historic development (as desired)

Structure: Data table (for processing) or cockpit report (e.g. for historic development review or comparisons)

C.3.1.3 GHG Forecast Report

Purpose: A special form of management scenario report (see paragraph C.3.2.1 below), showing estimated impact of activities (e.g. "business as usual" vs. new management scenarios) on carbon stocks and GHG emissions.

Contents: Scenario model outputs for carbon stock and GHG emissions development depending on forest management activities

Structure: Cockpit report

C.3.1.4 Subnational Carbon Stock and GHG Emission Map

Purpose: Mapping carbon stocks and emissions in forests; combined with risk maps and activity forecasts (same data as GHG Forecast Report above), this can be used to identify current and future GHG emission hotspots.

Contents: Carbon Stocks per area, Emissions per area (including non-CO2 emissions), Stock change

Structure: Map

C.3.2 OTHER REPORTS

C.3.2.1 Management Scenario Report

Purpose: Forest management scenario reports allow a comparison of two or more forest management scenarios, modeling activities' impact on a key forest management targets as well as on SDGs.

Contents: Model outputs for forest products and services (timber volume / growth, protection performance, recreational value, etc.), SDG indicators (including environmental impacts) depending on forest management activities.

Structure: Cockpit report

(**Comment:** Forest management scenario modeling and impact reporting are key elements of DSS. Consequently, details on the forest management scenario report and the related GHG reports will have to be specified in a joint DSS/MRV architecture workshop.)

C.3.2.2 Forest Cover Change Map

Purpose: Show change of forest stock and areas, including reason for stock reduction/loss (harvest, fire, pests)

Contents: Forest area, current stock, previous reporting period stock, impact factors (harvest, fire, pests)

Structure: Map

C.3.2.3 SDG Impact Report

Purpose: Indicate overall contribution / impact of forestry activities on the UN Sustainable Development Goals (SDG).

Contents: SDG indicators (including environmental impacts) depending on realized forest management activities.

Structure: Cockpit report (standalone or integrated in other cockpit reports, e.g. management scenario reports, GHG forecasts or historic comparisons).

C.3.3 ANALYTIC REPORTS

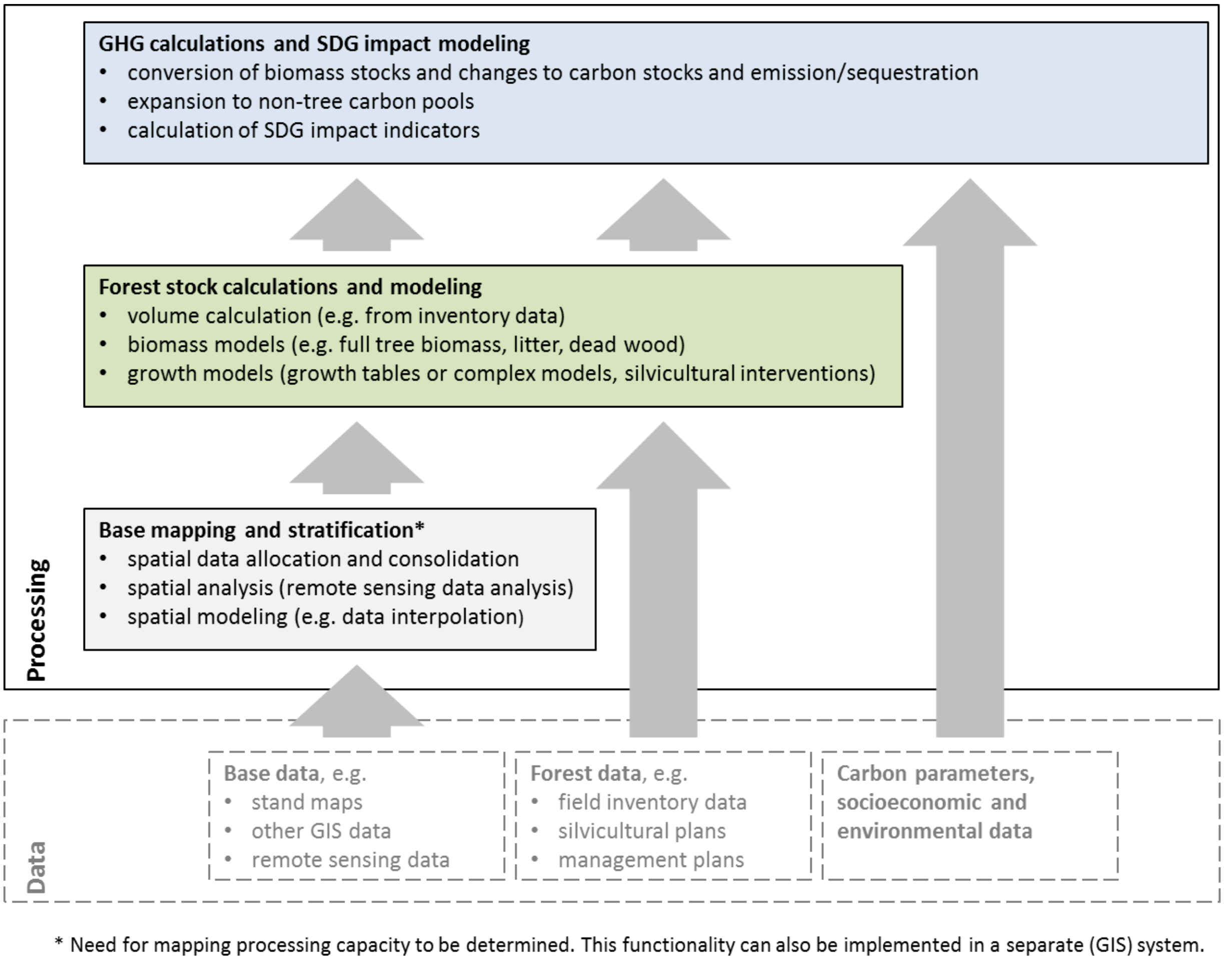
Analytic reports link different results and data sources to generate additional information, e.g. historic development, cause-and-effect relations, risk maps, policy impact, etc.). Such reports are technically not MRV functionality and thus are not further specified in this concept. However, the MRV data and reporting architecture must allow for such reports to be added or linked at a later time.

C.4 DATA PROCESSING LAYER

Figure 0-1 and the following paragraphs provide a general overview for key processing functions to generate data for the reports described in the previous section. In essence, the MRV processing ensures correct and transparent calculation of GHG balance and impacts on SDGs from area-based activity data.

As with the reporting functionality, the processing architecture is strongly linked to the DSS. Depending on functionality available in DSS, processing approach may have to be adapted.

Figure C.4-1: Data processing hierarchy



C.4.1 BASE MAPPING AND STRATIFICATION

Spatial references and area information is crucial for correct quantification of activity impacts and development. However, this data is not necessarily generated in the MRV core system. The spatial information described below can also be imported from other systems (e.g. GIS) as fully processed datasets.

C.4.1.1 Stand maps

Purpose: Stand maps are used to identify and quantify forest stands (management units with relatively homogenous conditions and structure) and to plan intervention activities.

Calculation: Stand maps are usually GIS-based spatial representations of forest management areas, classified in different stand types. Additional information may be added from DSS, MRV or other sources.

C.4.1.2 Forest strata maps

Purpose: Forest strata maps are used in addition to stand maps to calculate and verify forest stocks. Forests are categorized on a large scale and empiric stocks associated per stratum.

Calculation: Forest strata maps are commonly generated in GIS systems based on remote sensing image analysis (and verified in ground truthing samples in the field). Stocks per stratum are calculated from field inventory data, potentially combined with growth models.

C.4.2 FOREST STOCK CALCULATIONS AND MODELS

Forest stocks are the result of management activities and other impacts (ecological, pests, fire, etc.). They are also the basis for the calculation of carbon stocks and GHG emissions. Thus, accurate representation and modeling of stand-level forest stocks and activity impacts is essential for the MRV system.

C.4.2.1 Stand volume calculations (empirical yield tables)

Purpose: Expected growth and commercial timber volumes are calculated for managed production forest stands (applicable only to fully stocked single species stands).

Calculation: Tabular growth and yield tables with estimated stock based on age and site-index (bonitaet) as set in the management plans to determine volume per ha. The stock and growth values are multiplied with respective stand areas.

Comment: The approach is only viable in commercial production forests (single-species, even aged stands) under standard silvicultural approaches. For mixed stands or more complex structures (varying crown closure, selective harvesting and rejuvenation approaches), applying yield tables will deliver incorrect results. For such cases, more sophisticated growth and yield models have to be used (see below).

C.4.2.2 Complex growth models

Purpose: Parametrized models allow more flexible growth calculation for stands or even individual trees. Such models can be applied to estimate stock development for a broad variety of stand structures and management approaches. They can also provide sufficiently detailed volume data to derive further information, e.g. total biomass or total carbon stock.

Calculation: A broad variety of growth and management models can be developed, from stand volume quantification down to individual tree simulations. As DSS will include a growth model for all relevant species, MRV functions should use the same.

C.4.3 CARBON STOCK CALCULATIONS

Carbon calculations are the core of a forestry GHG MRV system. Impact of each forestry activity on sequestration of carbon from atmospheric CO_2 and GHG emissions, especially CO_2 and CH_4 (Methane, e.g. from burning), has to be calculated diligently and conservatively. The following paragraphs summarize the processing requirements to calculate carbon stocks and baseline models (i.e. reference scenarios for calculation of activity impact). More information on baseline models and carbon calculation can be found in Section D: of this report.

C.4.3.1 Baseline models

Purpose: Calculate stock and emissions for “business as usual scenarios” to be compare to project scenarios (after intervention).

Calculation: Depending on activity type and carbon pool. An overview of baseline approaches is provided in section D.1

C.4.3.2 Expansion and conversion factors

Purpose: Expansion and conversion factors are used to calculate total biomass and carbon stocks and changes from (commercial) inventory volumes. These relatively simple factors can be used instead of more accurate (and complex) models if the latter are not available and if factor-based estimates are conservative.

Calculation: Calculation varies depending on type of conversion/expansion. Factors commonly used are:

- Wood density per species: to calculate wood mass from volume
- Biomass expansion factor (BEF): to estimate total biomass (or total volume) from stem volume
- Root-to-shoot ratio: to estimate below-ground biomass from above-ground biomass
- Carbon ratio: to calculation amount of carbon in (tree) biomass
- GHG conversion factors: to convert GHG impact of non-CO2 emissions to “CO2 equivalent”

C.4.4 SDG IMPACT MODELING

C.4.4.1 SDG impact models

Purpose: Estimate impact of forestry activities on SDGs, to be reported in Management Scenario Reports (see paragraph C.3.2.1) and Sustainable Development Reports (C.3.2.3).

Calculation: Activity impacts calculated based on indicators specified in Section E:.

C.5 DATA MANAGEMENT LAYER

Data management layer will be specified in collaboration with DSS. General requirements according to Section B.4 apply.

C.6 DATA INPUT AND INTERFACES LAYER

Data input and interfaces layer will be specified in collaboration with DSS. General requirements described in section B.4 apply.

Table C.6-1 lists high-level sources which have been identified (and are to be further evaluated) for the Turkish Mediterranean forests. For these sources, a consistent interface needs to be set up. Further sources, especially on for specific model parameters (e.g. climate, soil, socioeconomic factors) will have to be researched as models are specified for MRV Level 2.

Table C.6-1: Selected key sources for MRV system (as identified)

Source Name	Owner	Data	Status
ENVANIS	GDF	Forest Management Plans, especially forest status, functions and planned activities, growth tables	Active
ORBIS	GDF	Various, very broad forest information	Offline (planned to be reactivated for pilot sites)
Forest Map (e-Harita)	GDF	Various GIS information: Forest districts, stand map, forest villages, non-timber products (honey)	Active (online)
Fire Management System	GDF	Forest fire infrastructure and fire data (GIS)	Active
Statistical data (various)	TUIK	National statistical information (e.g. population, economics, sustainable development indicators)	Active (online)
Noah's Ark National Biodiversity Database	Ministry of Forestry and Water Affairs, IT Dept.	Species, areas, habitats	Active
ARIS (Land cover database)	Ministry of Forestry and Water Affairs	Land cover data (including CORINE data)	Active (Online)

SECTION D: BASELINE & CARBON CONVERSION

D.1 BASELINE SCENARIO MODELLING

To quantify carbon sequestration and emission reductions for forestry activities (see Section A: for activities in scope and baseline scenarios and stock development), baseline models are essential. The models are designed to quantify the development of an area in the absence of the envisaged forestry activity (i.e. afforestation or improved forest management).

For all activities the net CO_2 fixation can be calculated applying the formulae:

[GHG emission reductions (in tons)] = ([carbon stock change in project scenario] – [carbon stock change in baseline scenario])

Key pools for the estimation of annual changes in carbon stocks are tree above-ground biomass, below ground biomass, dead wood, soil carbon and wood products depending on activity and pool selected.

D.1.1 ABOVE GROUND TREE BIOMASS (AGB):

Stock modeling is always based on field measurements in sample plots (e.g. forest inventory). Development of stocks is forecasted applying one of two general types of models used for baseline calculation: Sophisticated forest management models (required especially in methodologies for temperate forests) or simpler, spreadsheet-based models. In both models, key elements considered are

- Stocks from inventory base data (required to be less than 10 years old)
- Expected growth (e.g. mean annual increment)
- Harvesting volumes (from FM plans / baseline scenario)
- Mortality, incl. natural disturbances

D.1.2 DEAD WOOD (DW; IF SELECTED)

For dead wood pools, different models are applied. And while standing DW is usually sampled along with the live trees, lying deadwood is sampled differently with the line sampling approach. Stocks are then calculated based on decay function (usually a 10 year linear decay function or more conservative) or conservative assumption of "instant emission".

D.1.3 HARVESTED WOOD PRODUCTS (HWP; IF SELECTED)

Harvested wood products are usually modeled based on the amount of timber harvested (i.e. harvest volumes according to FM in baseline scenario). All carbon standards and methodologies consider wood products with a lifetime longer than 100 years as permanently stored.

- VCS and ACR both apply the "1605b" method, developed by the US Dept. of Energy[15.] This approach quantifies HWP for US commercial forests: Harvested wood is categorized in species and wood product. Wood density and product lifetime determine carbon stored >100 years.
- VCS also allows the method according to Winjum et. al (1998)[16], which is applicable internationally, splitting harvested wood volumes into "fractions" with production yield ratios and different product lifetimes depending on forest regions (boreal, temperate, tropical). The fraction with a lifetime >100 years is considered permanent.

D.1.4 SOIL ORGANIC CARBON (SOC; IF SELECTED)

Soil organic carbon (SOC) change is measured against a reference SOC level, either pre-intervention measurements on site or reference values from comparable sites. Measurement shall follow accepted sampling and analysis protocols such as the ICRAF protocol[17] and the VCS SOC Module[18]. If reference levels from a different site or from peer-reviewed publications are used, proof of applicability to the project site must be provided.

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[15] "Section 1605(b) - Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program; http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf

[16] Winjum, J.K., Brown, S. and Schlamadinger, B. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. Forest Science 44: 272-284

[17] Aynekulu, E. Vagen, T-G., Shephard, K., Winowiecki, L. 2011. A protocol for modeling, measurement and monitoring soil carbon stocks in agricultural landscapes. Version 1.1. World Agroforestry Centre (ICRAF), Nairobi. (http://www.samples.ccafs.cgiar.org/uploads/2/6/8/2/26823384/icraf.pdf)

18 Verified Carbon Standard (VCS) 2011. Module VMD0021 Estimation of Stock in the Soil Carbon Pool (Version 1.0). (http://www.v-c-s.org/methodologies/estimation-stocks-soil-carbon-pool-v10)

D.2 CONVERSION TO TONS OF CO_2

To assess net benefit of an intervention, GHG sequestration an emission reductions are expressed in tons of CO_2 , (equivalent). Conversion of measured (tree) volumes to CO_2 equivalent is done in a multistep process:

D.2.1 CALCULATION OF BIOMASS

D.2.1.1 Above ground biomass (AGB)

AGB stocks are calculated from the inventory (or model) data using either

- a biomass expansion factor (BEF) and species or species-group based wood density[19], to convert (merchantable) stem volume to full above ground biomass, or
- an allometric function calculating tree biomass directly from the measured parameters (usually stem diameter and height).

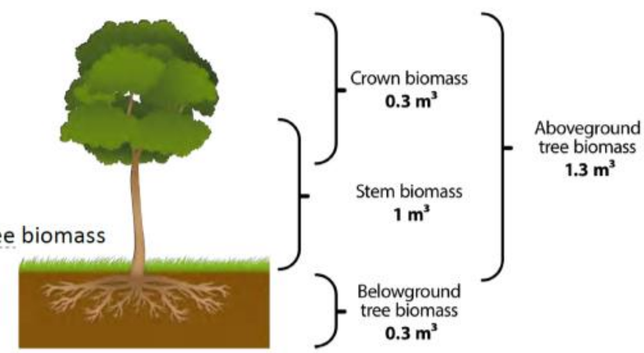
Figure D.2-1: BEF and wood density

Biomass Expansion Factor (BEF) and **Root-to-Shoot ratio** I The following graph shows how the BEF and Root-to-Shoot ratio are determined based on the ratio of different parts of the tree.

Examples:

BEF
= Aboveground tree biomass / Stem biomass
= 1.3 m^3 / 1 m^3
= 1.3

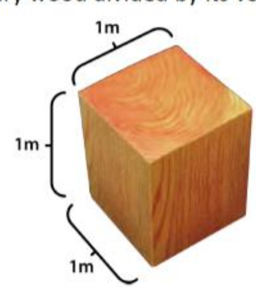
Root-to-Shoot ratio
= Belowground tree biomass / Aboveground tree biomass
= 0.3 m^3 / 1.3 m^3
= 0.23



Wood density I The woody density is the ratio between the mass of dry wood divided by its volume.

Example:

Wood density
= Mass / Volume
= 0.6 t / 1 m^3
= 0.6 t / m^3



Often the unit t (tonnes) is expressed as tdm (tonnes of dry matter).

[19] Methods refer to UNFCCC guidelines which provides biomass conversion and expansion factors, B(C)EF, for a variety of forest types and climate regions around the globe.

D.2.1.2 Below ground biomass (BGB)

BGB is mostly deducted from AGB applying a root-to-shoot factor. Common source for the root-to-shoot factor are IPCC guideline documents, project-specific research, or peer-reviewed publications.

D.2.1.3 Dead wood (DW)

DW approaches for initial calculation of mass vary (from simple “machete tests” to estimate density to species-specific density with a discount for decay).

D.2.1.4 Harvested wood products (HWP)

For HWP, simple wood density (species-specific, per species group, or wood type (hardwood vs. softwood) are used to convert the volumes to mass.

D.2.1.5 Soil organic carbon (SOC)

If not applied from reference site documentation or peer reviewed publications, Soil organic mass is measured in a laboratory process.

D.2.2 CALCULATION OF CARBON CONTENT AND CONVERSION TO CO_2

For woody biomass, a carbon fraction is applied to the total mass to determine carbon stock. Common default value for the carbon fraction of wood is 0.5. With evidence of applicability, more specific carbon fractions from peer-reviewed sources may be applied.

For SOC, the organic mass is also multiplied with a carbon fraction, using a default of 0.5 unless evidence is given to support a more specific carbon fraction.

CO_2 mass is then calculated applying the molecular weight ratio from C to CO_2 (=44/12).

SECTION E: SDG MONITORING

E.1 INTRODUCTION

This section presents a proposed high-level approach to monitoring the key contributions of Turkish forests to the Sustainable Development Goals (SDGs). The rationale behind the approach presented is to create a system that:

- Is simple to use, read and understand.
- Focuses on the key, direct SDG contributions made by Turkish forest management activities (as opposed to those where the contribution is at a national, aggregated level).
- Is inexpensive to apply while still able to credibly demonstrate a contribution.
- As a Level 1 approach it can be further built upon as systems and information becomes more sophisticated and readily available.

The approach presented follows a review of key literature and engagement with expert stakeholders in Turkey. A prototype for a graphical reporting tool is also presented.

Contents

1. Summary of background research and expert input
2. Level 1 Monitoring approach and suggested indicators
3. Reporting

E.2 SDG BACKGROUND RESEARCH AND EXPERT INPUT

The Sustainable Development Goals[20] (SDGs) are an aspirational series of goals, indicators and targets that succeed the Millennium Development Goals in the inter-governmental development agenda. The final document was adopted in September 2015 with work continuing in relation to agreement of indicators and country priorities. In total there are 17 SDGs and 169 associated Targets to be achieved by 2030:

Figure E.2-1: SDG Goals

The role of climate change in the SDGs is included under Goal 13 which specifically cross-references the Paris Agreement (and vice-versa) to ensure a holistic approach to climate change and sustainable development. The role and impacts of forests touch upon a number of SDGs and Targets (including Goal 13), not least SDG 15 (Life on Land).

[20] https://sustainabledevelopment.un.org/sdgs

The SDG Goals are summarized as follows:

Figure E.2-2: SDG Goals and Definition

GOAL	DEFINITION
1 – No poverty	By 2030 End poverty in all its forms, everywhere
2 – No hunger	By 2030 achieve food security and improved nutrition and promote sustainable agriculture
3 – Good health	By 2030 Ensure healthy lives and promote well-being for all at all ages.
4 – Education	By 2030 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5 – Gender equality	Gender Equality and Women's Empowerment: By 2030 Achieve gender equality and empower all women and girls.
6 – Water and San.	By 2030 Ensure availability and sustainable management of water and sanitation for all.
7 – Energy	By 2030 Ensure access to affordable, reliable, sustainable and clean energy for all.
8 – Economic Growth	By 2030 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9 – Infrastructure & industrialisation	By 2030 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10 - Inequality	By 2030 Reduce inequality within and among countries.
11 - Cities	By 2030 Make cities and human settlements inclusive, safe, resilient and sustainable.
12 – Sustainable production & consumption	By 2030 Ensure sustainable consumption and production patterns.
13 – Protect the planet	By 2030 Take urgent action to combat climate change and its impacts.
14 – Life below water	By 2030 Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15 – Life on land	By 2030 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16 – Peace and justice	By 2030 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels Targets.
17 - Partnerships	By 2030 Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Sustainable development is often argued to be a sovereign issue and hence the SDGs represent a significant movement towards global alignment. It is still however important to recognize that the application of the goals within a given country, location and sector will be directed and led by the host country.

The selection of priorities, indicators and method of MRV remains under discussion at the time of writing. A number of areas of further development within the SDG process are acknowledged in the adopted documents[21]:

- That each country faces unique challenges and dynamics (para 56)
- That baseline data for the SDG indicators is not in place for many of the goals (para 57)
- Cohesive, nationally owned strategies should be put in place within the context of a global partnership (para 63)
- Includes voluntary review and reporting to the partnership (para 74)
- Rigorous, transparent, data-led MRV will be required (para 74g)
- Global indicators[22] will be developed and adopted, supplemented by regional/national indicators that are contextually appropriate (para 75)

As at time of writing the indicators for use at global level have been drafted and a number[23] have been adopted for use at global level (around 60%) with work ongoing to review the rest. The United Nations have also instigated the UN Data Revolution[24], an initiative designed to make best use of 'big data' in support of the SDGs.

The SDGs should be considered holistically. A large number of the targets and indicators, when read together may imply both positive and negative contributions. For example an activity concerning the planting of trees or crops may imply a positive impact for climate change or perhaps biodiversity but a potentially negative impact on water availability. It is therefore recommended that at minimum a net-positive approach with a no-critical-harm safeguarding principle be established. In the example stated this could include an assessment that it is ok to plant trees for the benefit of climate change but not in water scarce or stressed areas.

The SDGs were reached by international consensus. This means that in many areas they have stepped away from the common language of Logical Frameworks typically used in development practice. Practically this means that some targets are in fact activities or outputs rather than outcomes or impacts.

However when read as a whole (i.e. along with a fixed goal to be achieved by 2030) it could be argued that an output-based target and indicator become a de facto outcome or impact.

E.2.1 UNDP TURKEY AND SDG

The United Nations Development Programme (UNDP) has been active in Turkey for fifty years[25]. The role of UNDP is to assist governments in the facilitation and implementation of the SDGs by providing support and expertise primarily. The priority areas identified by UNDP in Turkey are climate change and the environment, inclusive and sustainable growth and inclusive and sustainable democracy/governance.

Of particular relevance to the forest MRV initiative is the focus on climate change and environment wherein natural resource management and climate mitigation and disaster resilience are identified as key pillars.

21 https://sustainabledevelopment.un.org/post2015/transformingourworld
22 http://unstats.un.org/sdgs/
23 http://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-SDGs-Rev1-E.pdf
24 http://www.undatarevolution.org
25 http://www.tr.undp.org/content/turkey/en/home/ourwork/overview.html

While baseline definition, national priorities and finally adopted indicators remain under review (including for Turkey) a number of studies have been conducted into implementation at country level. Of particular interest are two reports:

1. A Turkish Ministry of Development Report (2016) entitled 'Report on Turkeys initial steps towards the implementation of the 2030 agenda for Sustainable Development', July 2016. The report summarises the work currently underway towards the development of the 11th National Development Plan (2016 TBC) that will give greater clarity on the integration of Turkey's current national indicators for Sustainable Development and those of the SDGs. The report also highlights the strong overlap between Turkey's existing approach and the SDGs and that the intention is to include the SDGs in the NDP. Finally the report highlights that TurkStat will ultimately be responsible for coordinating and reporting on national SDG statistics and a process of refinement and integration is therefore likely to be required with regards the proposed approaches contained in this report.

2. Post-2015 Data Test (2015) entitled 'Measuring Sustainable Development to 2030: A view from Turkey[26], is informative and helpful. The report highlights the key issues for Turkey are to overcome the 'middle income trap', resolving gender equality issues, and ensuring environmental sustainability. It also acknowledges the relative success of Turkey in implementing the MDGs, particularly in the eradication of poverty. In addition the report surmises that:

"Regarding environmental sustainability, what some of the targets and indicators measure, such as a percentage of a country's forest area or frequency of disasters, may need careful interpretation in country contexts because progress is largely determined by a country's geographical location. Some indicators, such as that on water availability, are both nationally and globally important and should be included. "

and

"Some indicators, such as that on a country's ecological footprint, are more relevant as part of a globally implemented programme that includes comparisons. The biggest concern for governance-related indicators is that many are based on perceptions. Not only do perceptions differ among different social groups, but in Turkey they may not be correctly reported. Information is often unsuitable for statistical use."

These findings are helpful in identifying SDG MRV elements for the current initiative as well as providing important guidance on how they should be approached. Accordingly this document focuses its efforts on the following proposed methodology:

- Identification of relevant activities related to the forest MRV procedure under development
- Identification of Primary SDG target potential contribution and indicators
    - Note that this report does not have sufficient mandate to consider potential detrimental impacts of forestry activities though it is acknowledged that these exist and should form part of GDF's overall strategic approach.
- Outline recommendation of MRV methodology or approach (noting that detailed procedures for these elements are beyond the scope of this appointment)

[26] http://www.post2015datatest.com/wp-content/uploads/2015/05/Post2015_Data_Test_Turkey.pdf

Based on the above background research the selection of primary SDG targets and indicators will be based on the pillars identified by UNDP Turkey and Post-2015 Data-test report. In summary the focus will be on:

- Primary outputs and outcomes – the results of the activity that can be directly monitored, as opposed to those outcomes that may indirectly occur. For example we may select indicators that focus on clean water supply but stop short of recommending indicators around impact on human health downstream.
- Focus on climate change, environmental and social targets and indicators prioritized for positive contributions. These were tested with a Turkish expert for completeness and appropriateness before finally including.
- The indicators proposed are based on:
    - Review of currently proposed and/or adopted SDG indicators and compare with:
        - Review by Turkish environment and forestry expert
        - Questionnaire responses from Turkish ministry officials and experts
        - Experience of Gold Standard
    - The indicators proposed reflect a mixture of practicality and availability of existing data sets. As a Level 1 approach they are expected to be further developed and refined.
- The indicators proposed or suggested are not exclusively the same as those included within the SDGs. This is recommended for further review as the NDP Roadmap is further developed and TurkStat begins to settle on a final monitoring approach.

As noted in the adopted SDG documentation the methodology for selecting and assessing baseline for the targets and indicators is not yet finally agreed. This paper therefore proposes some potential options that may be available.

It is acknowledged that as the SDG agenda progresses in Turkey that the identification of national priorities and indicators may change. The proposals in this document should therefore be considered a starting point for an approach that is likely to firm up in the coming months and years.

It is recommended that the relevant Turkish government departments engage with each to create a consistent approach to the SDGs and SDG reporting if this is not already underway. UNDP would be the obvious facilitator of this approach.

E.3 SDG MONITORING APPROACH

The nature of the SDGs is to promote positive change towards the various Goals included. This Level 1 Monitoring Approach is based upon 3 critical elements as follows:

- An approach to setting the baseline from which monitoring will take place.
- An approach for setting targets to be achieved by the Turkish forest sector in their contribution to achieving the SDGs.
- An approach to selection and monitoring of indicators

This report focuses primarily on the third bullet though briefly the first two are also discussed. It should be noted that the MRV approach briefly described in the third bullet does not inherently require a baseline or a target, the approach can operate simply as a tracking system if preferable.

The system is intended to be applied at Management Unit level with GDF aggregating data into a national picture.

Baseline setting – setting a baseline is important as it provides clarity as to the progress being made towards the SDGs. As yet a globally accepted baseline approach has not been adopted under the SDGs. In the case of Turkish forests two basic options are available, albeit with various sub-options briefly noted as follows:

- Option 1 – Baseline set using historic data representing 'business as usual' case. Methods could include:
  - Taking a snapshot prior to implementing change programs and conducting monitoring.
  - Establishing a business as usual case that could be applied nationally, regionally or locally
  - Setting guidelines to assist forest managers to demonstrate the business as usual case.

- Option 2 – simply monitor progress year on year with year one effectively becoming baseline.

It is recommended that the baseline approach be developed in line with the SDGs and/or Turkish Sustainable Development Index for consistency with other sectors.

Targeting – the proposed reporting approach contained in this report allows for ongoing comparison with baseline and potentially also a target. It is recommended that targets (i.e. for each identified SDG area) for Turkish forests contribution to the SDGs are set in order to properly focus and give momentum to efforts in the sector.

Monitoring Indicators: The approach proposed requires the collection and reporting of data concerning a series of indicators that demonstrate the positive contributions of Turkish forest activities. The selection of indicators has been based on the following process:

1. Define the activities proposed for inclusion
2. Map all relevant potential positive and negative SDG contributions of each activity
3. Prioritize the contributions to create a short list based on:
   a. How directly the contributions relate to the activity
   b. How significant the contribution is
4. Review of proposed contributions with Turkish civil society and policy stakeholders
5. Select monitoring indicators based on the Logical Framework

E.3.1 SDG CONTRIBUTION

There are 7 activity types identified within the MRV protocol (see MRV Concept) and a total of 8 key contributions across 4 of the SDGs were identified, along with indicators that could be used for MRV[27].

The SDG priority areas highlighted in Table E.3-1 below, were discussed in detail with an expert from Nature Conservation Center (aka DKM) and agreed as the key, relevant and direct contributions of Turkish forests.

Table E.3-1 details the key SDG contributions and how these map across the 7 activity types (i.e. for which activity type is the contribution relevant). It is noted that the SDGs selected are not exhaustive and that forests offer a wider contribution potential that could be monitored by extension of this approach.

[27] UNDP Turkey together with NGOs and GDF is currently also working on SDGs in relation to Sustainable Forest Management criteria. Results thereof are expected shortly. Respective contact is Nuri Ozbagdatl.

Table E.2-1: SDG Contribution Mapping

Sustainable Development Goals	Activity Type						
	A/R		IFM			Conservation	
SDG Goal	Timber Harvest	Conservation	Prevent loss of stocks	Increase stocks	Increase HWP	Conservation	Restoration
SDG 1 - No Poverty							
SDG Contribution Identified: Instigation or increase of smallholder income from forestry and forest products. Related SDG Target: 1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions							
SDG 6 - Water and Sanitation							
SDG Contribution Identified: Water filtration - improved water quality and quantity outputs from forested areas. Related SDG Target: 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes							
SDG 8 - Good Jobs and Economic Growth							
SDG Contribution Identified: Domestic timber and other produce enhances domestic economy and improves resilience. Related SDG Target: 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead							
SDG Contribution Identified: Enhanced quantity and quality of employment in forests and supply chains Related SDG Target: 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.							
SDG 13 - Protect the Planet							
SDG Contribution Identified: Contribution to climate resilience Related SDG Target: 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries SDG Contribution Identified: Contribution to climate mitigation through sequestration - COVERED BY MAIN MRV CONCEPT							
SDG 15 - Life on Land							
SDG Contribution Identified: Conservation/restoration/protection of habitats and progress towards sustainable management of forests: Related SDG Target: 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements Related SDG Target: 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation							
SDG Contribution Identified: Contribution to reducing flood risk and improving resilience to flood events Related SDG Target: 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world							
SDG Contribution Identified: Protection/restoration of temperate/mountainous forest ecosystems. Related SDG Target: 15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development							
SDG Contribution Identified: Enhancement and protection of habitats. Related SDG Target: 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species							
SDG Contribution Identified: Enhancement and protection of biodiversity. Related SDG Target: 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species							
SDG Contribution Identified: Protection/reduced soil erosion. Related SDG Target: 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world							

For each proposed SDG contribution a brief monitoring protocol is provided as follows, detailing the key indicator and methodology. Where possible indicators are used for multiple contributions to reduce monitoring costs.

Contribution to SDG 1: Instigation or increase of smallholder income from forestry and forest products.	**Related SDG Target:** 1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
Monitoring Indicator:	1 - SDG Adopted Indicator 1.2.1 Proportion of the population living below the national poverty line, disaggregated by sex and age group. 2 - Proportion of population at risk of poverty, disaggregated by sex and age group. Compare overall to national figures including year on year change (as a proportional %)
Potential methodologies:	DSS will project the number of direct and indirect jobs based on the timber harvest (and type) and silvicultural operations. This can then be converted this into income per worker and per household with the help of OGM. DSS will first project from US employment per vol of timber. This shall be done using both large and small equipment. OGM can then modify the relationships between timber harvest and employment using relevant Turkish data to inform conversion.
Suggested Monitoring Frequency:	Report annually ideally and compare to national figures.
Other notes:	None

Contribution to SDG 6: Water filtration - improved water quality and quantity outputs from forested areas.	**Related SDG Target:** 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
Monitoring Indicators:	1 - SDG Adopted Indicator 6.6.1 - Change in the extent of water-related ecosystems over time 2- Proxy - Change in Area (Ha) of natural forest cover or native planting 3 - Proxy - Change in Area or % of target buffer area areas bounding streams and river 4 - Proxy - Area of forests participating in IWRM/Water Stewardship schemes
Potential methodologies:	DSS shall base landscape contribution to water quality and quantity on the proportion of each stand structure within the landscape during that decade. They may relate the Water volume to amounts of open and savanna structures and water quality to area of other structures, for example using

	Satellite data/GIS mapping for area coverage. Change in Area of IWRM participation taken from survey of management plans may also be pursued. .
Suggested Monitoring Frequency:	Minimum every 5 years
Other Notes:	SDG adopted indicator 6.6.1 states Percentage of change in the [QUALITY AND FLOW] of water- related ecosystems over time. However at a large scale this is a difficult and expensive. Hence alternative 'proxy' indicators based on area coverage are proposed.

Contribution to SDG 7: Forest contribution to clean energy	**Related SDG Target:** 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix
Monitoring Indicators:	1—Determine the amount of residuals to be used for fuelwood after harvesting and milling; 2—Determine the amount of fossil fuel saved by using wood products in place of steel, concrete, and brick for construction uses.
Potential methodology:	Per equations as used by Prof Chad Oliver[28]
Suggested Monitoring Frequency:	Annual
Other Notes:	None

[28] Contact: Prof Chad Oliver, University of Yale, New Haven, USA

Contribution to SDG 8: Domestic timber and other produce enhances domestic economy and improves resilience. .	**Related SDG Target:** 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead
Monitoring Indicators:	SDG Indicator 8.4.1* Resource productivity interpreted as: 1 – Volume, tree size and product size mix (using Winjum's [29] table) 2- Projection of Non-timber Forest Products based on GDF preliminary indication and production rates where available
Potential methodology:	Local enterprise productivity and market data as collected by GDF/TUIK
Suggested Monitoring Frequency:	Annual
Other Notes:	None

Contribution to SDG 8: Enhanced quantity and quality of employment in forests and supply chains	**Related SDG Target:** 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.
Monitoring Indicator:	SDG Adopted Indicator 8.5.2 Unemployment rate, by sex, age group and persons with disabilities interpreted as: 1 - Change in Nr or % gain/loss employment in the forestry sector including comparison to national indicators
Potential methodology:	Census, local survey or ORKOY benefits information
Suggested Monitoring Frequency:	Annual if possible, minimum 2-3 years otherwise
Other Notes:	None

[29] Winjum, J.K., Brown, S. and Schlamadinger, B. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. Forest Science 44: 272-284

Contribution to SDG 13: Protect the Planet* *contributions of Turkish forest to carbon stocks covered elsewhere in main MRV protocol.	**Related SDG Target:** 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
Monitoring Indicator:	None – propose area of forest (Ha) included in local, regional or national climate resilience and disaster planning schemes.
Potential methodology:	GIS coupled with resilience planning
Suggested Monitoring Frequency:	Every 5 years
Other Notes:	None

Contribution to SDG 15: Conservation, restoration and sustainable use	**Related SDG Target:** 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
Monitoring Indicators:	Adopt SDG 15.1 indicators: DSS shall determine the change in forest stand structures within each management unit as well as changes within designated protected areas. In addition the FEM shall determine how much of a balance of stand structures for habitats is provided. Further indicators could include: 1 - 15.1.1 Forest area as proportion of total land area 2 - 15.1.2 Proportion (%area) of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type 3 - 15.2.1 Progress towards sustainable forest management (Area under management scheme
Potential methodologies:	Satellite data (for area coverage items), Turkey GDF annual reporting data contributed from local enterprises
Suggested Monitoring Frequency:	Every 5 years
Other Notes:	None

Contribution to SDG 15: Protection/reduced soil erosion	**Related SDG Target:** 15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development
Monitoring Indicator:	Adopt SDG Indicator 15.4.1 1 - DSS shall determine how much open and savanna And open structures are available within erosion-sensitive areas. 2 - Coverage by protected areas of important sites for mountain biodiversity (% area)
Potential methodology:	Turkey GDF Annual Report and/or satellite/GIS data
Monitoring Frequency:	Every 5 years
Other Notes:	None

Contribution to SDG 15: Enhancement and protection of biodiversity.	**Related SDG Target:** 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
Monitoring Indicator:	1 - DSS shall determine/demonstrate how much of each stand structure (useful as habitats) will be present in each management unit, for each decade, and (with maps) where it will be. 2 - Adopted SDG Indicator is based on 15.5.1 Red List Index. Plus: 3 - Incidences (or extent) of loss due to fire and pest. Include illegal logging once ORBIS developed.
Potential methodology:	See 1.8.6
Monitoring Frequency:	Annual

Example – Level 2

Level 1 indicator table

Contribution to SDG 15: Enhancement and protection of habitats.	**Related SDG Target:** 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
Monitoring Indicator:	Quality and variety of forest stock ascertained through forest inventory accounting: 1 – Change in % of native species (adapted to local conditions) 2- Change in % of close-to nature stand structures 3 – Change in area of High Conservation Value forests (as identified in management plans)
Potential methodology:	Per accounting methodologies
Monitoring Frequency:	Per accounting methodologies
Other Notes:	Using same stand structure data, DSS can plan (and determine) how much of stand structures Within an area that are critical to targeted species are present in each area, each decade, and where. This depends on the spatial data available for each species.

Example of Level 2 specification for SDG indicators (Not part of this mandate but required for implementation of SDG accounting in MRV):

Example: Indicator 1 - Change in % of native species (adapted to local conditions)

1. Refine indicator:
    a. Species distribution is based on basal area as measured in field inventory plots
    b. Local conditions are determined as ecosystem parameters: soil and climate
2. Specify data needs:
    a. species list with designation of native species
    b. inventory data: basal area per species
    c. soil data (key parameters such as soil structure, humidity, acidity, nutrients)
    d. climate data (especially temperature range, precipitation)
    e. soil and climate tolerance per species
3. Data source: e.g. forest inventory, field based measurement
4. Resolution: stand based
5. Monitoring frequency: every 10 years (NFI)

E.4 REPORTING & VERIFICATION

The data collected as per the simple approach outlined in Section E.3 should be recorded and reported in a straightforward, easy to follow reporting template. This allows reviewers to quickly ascertain progress and overall contributions of different activities.

The proposed approach is for the user to complete a simple dashboard that tracks previous and latest scoring and allows for quick comparison across the different SDG contributions. To allow for simple comparison of overall contribution a qualitative interpretation of the data collected is proposed as per the following scoring. For each data point/SDG contribution area:

Table 0-1: Qualitative interpretation

Score	Definition
3	Significant positive contribution across majority of forest activity area, no significant negative reports
2	Positive contribution across majority of forest activity area, no significant negative reports
1	Minor positive contribution, no significant negative reports
0	Neutral – no impact
-1	Some negative effects witnessed in areas – to be monitored and corrected
-2	Significant negative effects recorded – urgent action required

The dashboard template is provided separately to this report. It is recommended that this report is completed by the activity proponent/lead in line with the monitoring frequency indicated in Section 1 (i.e. every 2-3 years). Ideally this would entail a submission to GDF including any substantiating evidence. GDF could then either 'verify' at desk-level or spot check specific sites as needed.

PART II: FOREST MRV PLAN WITH CARBON APPROACH TAILORED TO TURKISH MEDITERRANEAN FORESTS

Part II of this document relates the MRV concept to the current situation and improvement potential for MRV in Turkey. The section is based on interaction with stakeholders in GDF and the new Decision Support System (DSS) project into which the MRV architecture will be integrated, making use of the data sources and models to be developed in DSS.
The following sections indicate the current data situation in Turkey including carbon accounting approaches and methodologies applied and the key GHG reporting produced today. On this basis, the way forward regarding data collection and management is drafted with focus on reporting systems to establish simple and straightforward access to carbon information.

This part is structured in 2 sections:

- **Section F: Current Carbon Accounting Approach and Improvement Potential** describes the current monitoring approaches, carbon accounting, reporting and improvement potential thereof.
- **Section G: Specifications for MRV Implementation** describes the specification for MRV implementation and reporting.

SECTION F: CURRENT CARBON ACCOUNTING APPROACH AND IMPROVEMENT POTENTIAL

F.1 CURRENT STATE OF TURKISH MEDITERRANEAN FORESTS[30]

Forests cover about 27 percent of Turkey (21.2 million ha). Turkey's Mediterranean forests cover an area of 9.4 million hectares in total. The Mediterranean forests are moderately fragmented due to past logging activities, yet in some parts (especially in the southernmost regions) relatively large continuous forest tracts remain. Mediterranean forests are listed as one of the global biodiversity hotspots of the world due to their exceptional biodiversity richness. Approximately five per cent of the flora of Mediterranean Basin is endemic. Turkey's Mediterranean forests are important for their biodiversity due to woody species richness, habitat diversity, wildlife, butterfly species richness, plant species richness and the existence of enclaves. Turkish Caucasus and Mediterranean areas support the most diverse forest ecosystems in Turkey. In particular, the Taurus Mountains, harboring Turkey's Mediterranean forest ecosystems, are accepted as centers of plant endemism.

The total carbon pool in Turkey's Mediterranean forests is currently estimated at over two billion tC . Illicit logging, fires, and pests cause annual sequestration rates to fluctuate: in 1990 the forests were a 41.7 million tCO_2 net sink; by 2000, the net forest sink increased to 62.3 million tCO_2, remaining stable or slightly increasing for the next

[30] From UNDP/GDF project documentation: Integrated approach to management of forests in Turkey, with demonstration in high conservation value forests in the Mediterranean region.

several years before going down in 2006; this was followed by a slight increase in the period 2007-2008 due to the introduction of controls on logging; but fell sharply in 2009 and 2010 due to widespread forest fires.

As noted above, Turkey's Mediterranean forests provide important global and national benefits related to carbon storage and biodiversity, along with other natural products and ecosystem services. Despite these values and benefits, however, the Mediterranean forests face several threats. Fortunately, large-scale deforestation ended in the late 1990s. However, about three million ha of the Mediterranean forest area have suffered from severe degradation due to past economic activities. Some of these 'forests' currently have a crown density of less than 10 percent. However, many areas have moderate-to-high regeneration potential, which if were allowed to occur, and in some areas be complemented by reforestation, would enable significant carbon build-up and connect currently fragmented forest patches.

Currently, the main threats to Mediterranean forests derive from anthropogenic wildfires, unsustainable fire wood collection by local villagers, illicit timber harvests and pests. These threats have impacts on multiple forest values associated with the ecosystem goods and services which they provide. Of particular interest are damages related to the loss of globally significant ecosystem services associated with climate change mitigation and biodiversity.

F.2 CURRENT FOREST ACTIVITIES[31]

Until recent years, the main and often sole purpose of forest management in Turkey was timber production. However, the last 10 years have seen the beginnings of a paradigm shift in forest management. There have been important developments concerning the integration of sustainable forest management criteria into forest management. Services other than timber production have started to be considered under the concept of 'functional forest management planning'. GDF began work on development of 'Sustainable Forest Management Criteria' in 1999. Out of six criteria developed to date, the following are directly related to protection of forests and related ecosystem services:

- Criterion 2: Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems,
- Criterion 3: Maintenance of forest ecosystem health, vitality and integrity,
- Criterion 5: Environmental and Protective Functions of the Forests.

Following the integration of sustainable forest management criteria into forest management, the forest management planning approach has also changed. In a process led by the Department of Forest Management Planning, services other than timber production are beginning to be integrated into the forest management planning process. Since 2006, forest management plans with special emphasis on ecosystem services have been prepared in some forestry units.

[31] From UNDP/GEF project documentation: Integrated approach to management of forests in Turkey, with demonstration in high conservation value forests in the Mediterranean region

F.3 CURRENT MONTORING APPROACH

F.3.1 HISTORIC FOREST INVENTORIES

There were two national forest inventories published in Turkey, in 1972 and 2004. These forest inventories were collected over periods of several years. The 1972 inventory included the period of 1963-1972, while the 2004 inventory included the period of 1973-2004. The inventory data is not specific to a certain year, but rather to the multi-year period. The inventories therefore do not show increases or decreases occurring annually in the forest areas.

F.3.2 ENVANIS

In 2004, the ENVANIS excel inventory and statistical database was established to provide information gathered during forest management planning. ENVANIS is based on full forest cover type mapping based on 1/25,000 infrared aerial photos which are used to determine standing forest stock and growth increments. Once the inventory data is compiled, final forest cover type maps are generated and are then used to develop forest management plans. Management plans are renewed at 10- to 20-year intervals following a forest re-inventory. The monitoring system also includes a stand-level GIS map indicating stand type and key parameters (updated along with management plans). The inventory and database are used as a basis for reporting to FAO and is connected to the GIS recording system on forest fires. Full integration of management plans and inventory data with other forest and land based data in FIS (ORBIS) system is planned but has not been completed yet.

F.3.3 FIELD INVENTORY

Currently, forest field inventories are performed in a 10-year cycle to serve as the basis for the update of management plans. Field inventories are primarily planned and performed by contractors responsible for the updates of management plans. Basic instructions for inventory planning (sampling) and field measurement procedures are described in GDF Rescript No. 299; however, field approaches do not appear to be fully harmonized. Sample plot sizes range from 400 m2 to 800 m2 with grid intervals between 150 and 600 m, depending on crown cover, forest function and structure. No inventory is done in young stands and degraded areas. Data collected includes (commercial) species, DBH, tree quality and health status for each individual tree, as well as age, dominant height (2 to 3 highest trees) on stand level. Various types of paper-based field forms are used to collect this data.

Commercial volumes are calculated from the data collected based on yield tables.

Figure 0-1: Example of field protocol for forest inventory

ÖRNEK ALAN ENVANTER KARNESİ

Ek 5

Bölge Müdürlüğü		Örnek Alan No.		Koordinat	
İşletme Müdürlüğü		Örnek Alan Büyüklüğü (m²)		X	
İşletme Şefliği		Meşcere Tipi Sembolü		Y	

Sıra No.	Tür Kod No.	1,30 m' deki Çapı (cm)	Kalite Sınıfı	Sağlık Durumu	Silvikültürel Durum	Yaş	Çift Kabuk Kalınlığı (mm)	10 Halka Kalınlığı (mm)	Ağaç Boyu (m)	Hakim Ağaç Boyu (m)

Kökeni		
	Doğal-Yarı Doğal (Tohum)	
	Doğal-Yarı Doğal (Sürgün)	
	Yapay	

Diğer Bilgiler :

F.3.4 OTHER MONITORING SYSTEMS

GDF also operates other forest related monitoring programs which are relevant for the carbon MRV:

- ORBIS the Forest Information System of GDF was planned to offer multiple forest services such as administrative, forest management, forest assets, forest ownership, status fields, forest fires, areas of silviculture, reforestation, forest ecosystem monitoring, roads, non-wood products, climate, water. The system faced several challenges from an IT perspectives (software, hardware, capacity) as well as data access and integration currently hold by different entities within GDF. At this point not much information is available concerning implementation status of this system.
- A very impressive and up to date central fire monitoring and intervention database and GIS management system. The tool includes stand-level forest data, fire risk maps, current and historic fire occurrences as well as live information on firefighting infrastructure, mobile equipment and personnel.
- A monitoring program on forest villages including forest-related activities (e.g. non-timber forest products) and socio-economic development
- A series of long term forest monitoring plots (Level 1 and Level 2) within the ICP Forests Programme. These include monitoring of tree stocks, growth as well as additional parameters (e.g. some soil carbon measurements).

F.3.5 IMPROVEMENT POTENTIAL

ENVANIS

While the ENVANIS represents an essential data management baseline, the system does not take into account all forest functions and services. For example, it does not include carbon pools, biodiversity habitat conditions, and fluxes. Under the current system, stands are classified based only on three criteria: species mix, crown closure and age classes.

Data quality assurance and transparency could be considerably improved by full integration of current management plan information, field data, GIS maps and analysis, and remote sensing data and analysis (satellite imagery). Also data concerning impact on SDGs should be included.

Volume calculations based on yield tables are limited to single-species, even-aged stands. With the introduction of more flexible management approaches, including multi-species stands managed for non-timber forest functions, improved growth models will be needed to correctly assess stocks.

To closely monitor and report forest status and changes for sustainable and multi-purpose management, a higher temporal resolution (frequency of data recording on forest stand level should be more than every 10 years) and spatial stratification (taking into account factors beyond silvicultural parameters) should be improved. Especially forest threats parameters such as anthropogenic wildfires, unsustainable fire wood collection by local villagers, illicit timber harvests and pests should be recorded and stored within the database.

Field inventory

Efficiency of field inventories is greatly increased by area stratification and adapted inventory design. Using multiple data sources (including previous field data, remote sensing and GIS data), allows very accurate definition and designation of strata, for each of which field sampling can be optimized (e.g. number of sample plots depending on variance within each stratum).

Manually entered data on paper sheets again re-entered into ENVANIS provides potential for errors on various levels. The use of tablets for data entry in the field as planned within ORBIS will certainly improve this situation. Further, it must be ensured that automated quality checks (e.g. maximum tree height, data format controls) and quality assurance processes are introduced for data collection, entry, and processing. An automated data exchange system between tablet and database/MRV system should be considered to prevent errors due to re-entering data manually into the database.

Measurement guidelines and field protocols must be updated to allow recording of data for non-tree carbon pools, SDG indicators and data related to other forest functions / benefits.

F.4 CURRENT CARBON ACCOUNTING

Turkey submits its National GHG Inventory Report (NIR) annually to the UNFCCC, last on May 26, 2016 with 2014 numbers for the forest sector. For all forest areas (forest definition according to Turkish Forest Law No: 6831, GDF, 1956), carbon stock and emissions from land use change are reported, applying UNFCCC area-based approach. Accounting under the Paris Agreement is not yet clear but on a technical level will likely be based on UNFCCC/IPCC approaches and models with country specific factors.

F.4.1 FOREST AREAS AND STOCKS

Forest area, area change, growing stocks and annual volume increments are calculated based on the ENVANIS database (see F.3.5). In contrast, non-forest land use changes in Turkey are assessed using the CORINE land cover approach.

F.4.2 CARBON STOCK CALCULATIONS

Carbon stocks (as well as gains and losses) for each area are calculated based on data listed in ENVANIS and the rules and procedures as described in GDF Rescript no 299, 2014. Conversion from commercial volumes to carbon stocks is done by applying IPCC tier 1 and 2 approaches for LULUCF.

For above ground biomass and below-ground biomass in forests, carbon stocks are calculated in five steps as follows (source: GDF Communication 299, 2014):

Step 1: Calculation of live biomass above and belowground:

AGB = STV * WD * BEF

Where AGB = Aboveground biomass (tons)
STV = Standing stem volume by species or species group (m3)
WD = Wood density (mass/volume ratio) by species or species group: 0.541 for deciduous species, 0.446 for conifers[32] (Tolunay 2012)
BEF = Biomass Expansion Factor to calculate total tree biomass from stem: 1.310 for deciduous species, 1.212 for conifers (Tolunay 2012)

BGB = AGB * R

Where BGB = Belowground biomass (tons)
R = Root-to-shoot ratio: 0.29 for closed coniferous forests, 0.24 for closed deciduous forests, 0.4 for coniferous forests with gaps, 0.46 for deciduous forests with gaps (FRA 2010)

Step 2: Calculation of carbon content in living biomass,

BC = (AGB + BGB) * CF

Where BC = Carbon in live tree biomass
AGB = Aboveground biomass (tons)
BGB = Belowground biomass (tons)
CF = Carbon fraction: 0.48 for deciduous, 0.51 for coniferous (FRA 2010)

Step 3: Calculation of carbon content in dead wood

CDW = AGB * 0.01 * CF

Where CDW = carbon in deadwood (
AGB = Aboveground biomass (tons)
0.01 = Ratio of deadwood / live aboveground biomass (FRA 2010)
CF = Carbon fraction: 0.47 for deadwood (FRA 2010)

[32] Wood density for important commercial species in Turkey is available (Table 6.17 in NIR) but it is not specified if this data was used for calculations in NIR.

Step 4: Calculation of the carbon content in litter

Country-specific litter content (ton/ha) according to Tolunay and Çömez, 2008.

Tablo:3 Ölü örtü karbon miktarı katsayıları

Ağaç Türü Grupları	Normal Kapalı Ormanlarda Ölü Örtüdeki Karbon Miktarı (ton/ha)	Boşluklu Kapalı Ormanlarda Ölü Örtüdeki Karbon Miktarı* (ton/ha)
İbreliler	7,46	1,86
Yapraklılar	3,75	0,93
Maki	1,70	0,42
Ağırlıklı ortalama	5,86	1,46

* Normal kapalı ormanlardaki ölü örtü karbon miktarının ¼'ü olarak alınmıştır.

Step 5: Calculation of carbon content in forest soils.

Country-specific soil organic carbon content (ton/ha) according to Tolunay and Çömez, 2008.

Tablo:5 Orman Toprağı İçindeki Karbon Miktarı Katsayıları

Ağaç Türü Grupları	Normal Kapalı Ormanlarda Topraktaki Organik Karbon Miktarı (ton/ha)	Boşluklu Kapalı Ormanlarda Topraktaki Organik Karbon Miktarı * (ton/ha)
İbreliler	76,56	19,14
Yapraklılar	84,82	21,20
Maki	79,60	19,90
Ağırlıklı ortalama	77,96	19,49

* Normal kapalı ormanlardaki topraktaki organik karbon miktarının ¼'ü olarak alınmıştır.

It is important to note however, that no information for deadwood, litter, and soil carbon pools were provided in the current Turkish NIR due to lack of adequate data on annual carbon stock changes.

In addition, carbon stocks in harvested wood products are calculated for the Turkey NIR , using historic UNECE and GDF data. Carbon stock in product categories "sawn wood" and "wood-based panels" are calculated and listed as carbon sinks over time. No specific information is given on longevity or decay of products.

F.4.3 IMPROVEMENT POTENTIAL

Forest area classification and base data

As stated in the Turkey NIR 2014/16, a key improvement potential is the improvement of area allocation / activity data for carbon calculation. Objective area designation and detailed classification (e.g. primary land use, forest type, status and functions, management approaches, ecological and socioeconomic environment) combined with more advanced growth and management models as well as activity-based stock change and carbon models can considerably enhance accuracy and scope of reporting. This is especially true for reporting of improved forest management (IFM) activities and impact on forest functions beyond timber production. By introducing new growth models and better area classification (e.g. combining remote sensing with optimized terrestrial inventory) and making use of technological advances on the data collection (field inventory), processing and analysis side (ORBIS, DSS, GIS systems), base data availability and quality will be significantly improved for a national MRV system.

Carbon stock calculation

Although carbon calculation is already done mostly on a Tier 2 approach with parameters specific to Turkey according to the 2006 IPCC Guidelines, there is improvement potential on several levels:

Base data quality, availability and resolution: A key element of carbon accounting is ensuring that the base data is complete, well-structured and of high quality, as described above. Having an excellent database not only assures accuracy of reporting, but also is essential for the design and development of better models. This also includes environmental information (soil and climate) to improve specificity of parameters (e.g for growth and form). A key quality aspect of base data is also that it is available on a high resolution, showing regional and local differences.

Calculations of growing stock: In a first step, improved growth and yield/loss models will allow more specific prognosis of forest development between inventories. More sophisticated models can further evolve as new and expanded data sources (especially additional inventory data) become available. This will also facilitate modeling of novel forest management approaches, e.g. in non-homogeneously structured forests (e.g. during rehabilitation) and improve specificity of models e.g. regarding species composition, climate and environmental situation.

Parameters for Tier 2 carbon calculation: Within the Tier 2 approaches, use of parameters specific to species, forest type and physical as well as climatic environment considerably increases accuracy. This includes databases with specific wood densities for all relevant species including non-commercial tree species in Turkey, as well as expansion factors taking into account species/species groups as well as forest structure and environmental factors impacting tree form and biomass (soil and climate).

Tier 3 calculations and activity-based modeling: With a more evolved data and modeling environment, introducing Tier 3 calculations increases accuracy and efficiency. This includes development of allometric functions to calculate biomass and carbon directly from parameters measured in the field (or, by proxy, from remote sensing data). New research and activity based, dynamic models can allow calculation of related carbon pools, e.g. litter and soil, as well as scenario forecasts. Though the latter is not specifically necessary for an MRV system, it facilitates ex-ante calculation and forest management decisions.

Missing carbon pools: An important improvement to the carbon calculation and monitoring in Turkey is the inclusion (or at least consideration) of the carbon pools currently missing from the reports, i.e. deadwood, litter and soil (compare Turkey NIR, 2014/2016). Data collection is specific to each pool and efforts should be in proportion with the carbon pool significance, i.e. for small or minimally changing carbon pools it may be sufficient to develop and verify default values for a simple Tier 2 reporting, whereas larger and dynamic pools should be actively monitored.

For **deadwood**, the recommended approach is to include data collection for both standing and lying deadwood in the forest field inventory. At a later point, empiric models can be built to calculate this pool based e.g. on forest type and management.

For **litter**, a simplified qualitative assessment in the field inventory combined with a set of sampling to establish reference values for all relevant forest and management types is adequate. In areas with higher amounts of litter, synergies with other functions (e.g. fire prevention) should be considered, e.g. for data collection.

For **soil organic carbon**, several related activities have recently started which could help improving the soil carbon stock information and establishing a national soil carbon stock map for forests:

- FAO-Turkey Partnership Programme (FTPP): web-based national soil information system covering agriculture soils only (in development).
- ICP Forests project's soil analysis in Turkish forest was initiated in 2015 January. It will be finished until 2019.
- The study on Mapping Soil Organic Carbon (SOC) Stocks in Turkey has been completed in 2015. (Aydın.G. et al. 2016: Stocks in Soils of Turkey. Istanbul Carbon Summit: Carbon Management, Technologies & Trade, Istanbul, Turkey 3 - 5 April 2014

In addition, we suggest establishing country-wide sample and database for the soil organic carbon pool in forest stands in a sub-sample of the regular inventory process.

F.5 CURRENT REPORTING

F.5.1 GHG REPORTING (NATIONAL GHG INVENTORY REPORT – LULUCF)

As mentioned above, Turkey, as an Annex I party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually on greenhouse gas (GHG) inventories. The last National Inventory Report (NIR) has been submitted in 2016, reporting national GHG emission/removal estimates for the period of 1990-2014. GDF is responsible for the LULUCF section of this report.

The report includes area, stock and carbon data for productive and degraded high forests (categorized as coniferous and deciduous) and coppices. Calculations follow the gain-loss approach according to 2006 IPCC Guidelines for National GHG Inventories. Table F.5.1 lists key reporting data contained in the National Inventory Report.

Table F.5-1: Summary table for data reported in Turkey's National GHG Inventory Report 2016

Data	(Sub)categories	Quantity	Time range	Change report	Source	Turkey NIR table/figure
Forest area	• Productive • Degraded • High forest coniferous • High forest deciduous • Coppice	Area (ha)	1971-2014	Yes	ENVANIS	Yes
Growing stock		m3	1990-2014	Yes	ENVANIS (yield table based)	Yes
Annual increment		m3	1990-2014	Yes	ENVANIS (yield table based)	Yes
Atmospheric C removal by living biomass in forests		tCO2e	1990-2014	Yes	ENVANIS-based calculations	Yes
Carbon emissions (forest remaining forest)	• commercial cutting • fuel wood gathering • other (forest fires)	tCO2e	1990-2014	Yes	ENVANIS-based calculations	Yes
Area converted to forest		ha	1971-2014	Yes	ENVANIS	6.9
Carbon gains in living biomass	• coniferous • deciduous	tCO2e	1990-2014	Yes	ENVANIS-based calculations	6.10

Carbon gains in dead organic matter (new forests)		tCO2e	1990-2014	Yes	Source not specified	6.10
Carbon gains in soil organic material (new forests)		tCO2e	1990-2014	Yes	Source not specified	6.10
Carbon losses in living biomass (grassland)		tCO2e	1990-2014	Yes	Source not specified	6.10
Carbon losses in dead organic matter (grassland)		tCO2e	1990-2014	Yes	Source not specified	6.10
Carbon losses in soil organic material (grassland)		tCO2e	1990-2014	Yes	Source not specified	6.10
Forest area converted to grassland		ha	1971-2014	Yes	ENVANIS	6.11
Carbon gains (grassland)	• Living biomass • Dead organic matter • Soil organic material	tCO2e	1990-2014	Yes	Source not specified	6.12
Carbon losses (forest land)	• Living biomass • Dead organic matter • Soil organic material	tCO2e	1990-2014	Yes	ENVANIS-based calculation (biomss) Source not specified (DW, SOC)	6.12
Number of forest fires in Turkey		#	2014	No	Forest Fire Statistics (GDF)	6.13
Area impacted by fire type	• Ground vegetation • Crown fires	ha	2014	no	Forest Fire Statistics (GDF)	6.13
Emissions of other GHG caused by fires	• CH4 • N2O • NOx • CO	tons	1990-2014	no	Forest Fire Statistics (GDF) IPCC 2006	
Annual Change in carbon stocks in forest areas	• Activities: Forest land remaining forest land, Land converted to forests, Forest land converted to grass land • Gains/losses in living biomass • Net carbon stock change in dead organic matter and soil	tC / tCO2e	2014	Yes	From all of above (except fire)	6.15

Figure F.5-2: Overview table for annual changes in carbon stock in forest areas (from NIR 2016)

Table 6.15 Annual changes in carbon stocks in forest areas, 2014

GHG sources and sink categories	Activity data	Changes in carbon stock (kt C)				
		Carbon stock change in living biomass			Net carbon stock change in dead organic matter and soil	Net CO_2 emissions/ removals (kt)
Land-use category	Area (kha)	Gains	Losses	Net change		
Total Forest Land	22 063.8	-18 590.3	8 256.2	-10 334.1	-3 842.8	-51 982.1
1. Forest Land remaining Forest Land	20 063.0	-17 833.4	8 015.0	-9 818.4	0.0	-36 000.9
2. Land converted to Forest Land	1 635.8	-736.1	152.1	-584.0	-4 449.9	-18 457.6
3. Forest Land converted to Grass Land	223.3	-20.8	89.1	68.3	607.1	2 476.4

The national inventory report also explicitly mentions sinks and sources not reported (see Figure F.5-3 below).

Figure F.5-3: Sinks and sources not reported (NIR 2016)

Completeness

As regards the inventory completeness, sinks and sources that could not be reported in the CRF tables are charted as follows:

Sink/source category	GHG	Explanation
Forest lands, soils	CO_2	Lack of adequate data on annual carbon stock changes in the soil in the Forest Land Remaining Forest Land soil organic matter
Forest lands, dead wood and litter	CO_2	Lack of adequate data on annual carbon stock changes in the litter and deadwood in the Forest Land Remaining Forest Land
Forestlands, Biomass Burning-Controlled Burning	CO_2, CH_4 and N_2O	Does not occur
Forest lands, drained soils	Non-CO_2	Drainage does not occur in the forests
Drained wetlands	Non-CO_2	No available data
Limestone application in croplands and grasslands	CO_2	Limestone application does not occur in the agricultural lands and grasslands.
Croplands, grasslands, wetlands and settlements, biomass burning	CO_2, CH_4 and N_2O	No available data
Croplands, disturbance associated with land use conversion to cropland	N_2O	No available data
Other land	CO_2	No available data

F.5.2 IMPROVEMENT POTENTIAL

Data transparency and granularity

To support transparency in reporting and provide decision support for forest management, it is important to increase data granularity in carbon stock and change reporting for all carbon pools. This implies data collection for pools not yet covered, i.e. dead wood, litter and soil (see section F.4.3 above) and refinement of models for the major forest carbon pools, i.e. living biomass (see section F.4.3). On the reporting side, the respective models should be made transparent to allow quality assurance, review and verification of data and calculations.

Change tracking and auditability over time

To allow the necessary evolution of data and models, it is important to ensure that changes in data structure, modeling and reporting are tracked and documented in reports. Only by doing this diligently can actual changes in stocks and areas be differentiated from changes due to updates in the processing systems and data (e.g. higher resolution imagery or improved growth models).

Data access and representation

Key to useful reporting is adequate access to data and reports. Currently data ownership is widely dispersed, sometimes unspecified and access is often difficult. Updates of key information are thus not ensured over time. A central repository and clear data and report management, including defined rules for access and usage, as well as responsibilities for updates can greatly improve reporting quality.

For public information, new channels and tools such as online reports and mapping systems (online geo portals, access for GIS systems) should be used to communicate results and allow broad use of data.

TREES* Forest Carbon Consulting

Gold Standard

SECTION G: SPECIFICATIONS FOR IMPLEMENTATION

This section describes specifications for the forest carbon MRV system as input for subsequent implementation in the Decision Support System (DSS) for Turkey, a separate GDF/UNDP project executed by Yale University.

G.1 BACKGROUND AND OBJECTIVES

G.1.1 INTEGRATED MRV AND MANAGEMENT INFORMATION

To allow reporting on land use and stock change as well as management of GHG-relevant activities, inventory data and change models (growth and harvest/loss) are needed in the MRV system. With inventory data available every 10 years for Turkish forests, adequate growth and loss models are needed to estimate development between inventories.

G.1.2 LINK TO SDG REPORTING

Section E.3 describes possible indicators to assess impact of forestry activities on Sustainable Development Goals (SDG). Linking or integrating these indicators to the Turkish Forestry MRV system allows early estimation of these effects. However, the SDG environment is evolving rapidly and the set of indicators proposed along with this concept may likely be replaced or refined as quantification approaches for SDG contributions are improved. Flexibility will thus be essential when integrating SDG monitoring.

G.1.3 INTEGRATION WITH DECISION SUPPORT SYSTEM

The MRV system as described in this concept is not intended to be a standalone tool but rather should be integrated with other management and reporting environments. The Decision Support System currently being designed for Turkey is considered a key component and is needed to establish the data and modeling environment as well as reporting functionality also for the MRV system. Therefore, this concept will provide limited requirements for the data and modeling up to the tree or stand volumes, to allow best practices to be implemented in the DSS. For the same reasons, reports are also specified on a requirements level rather than as fixed technical specification. The objective is to realize synergies with tools and interfaces built for the DSS as broadly as possible.

G.2 CARBON ACCOUNTING

G.2.1 ACCOUNTING PRINCIPLES

Three general principles shall guide the forest MRV carbon accounting requirements:

- Carbon calculation for all tree-based carbon pools shall be based on forest inventory data and respective volume models (AGB, BGB, DW). To estimate changes between inventories (growth and activity impacts), improved, Turkey specific models (Tier 3) should be applied.
- For non-tree carbon pools currently not documented for Turkish forests (LI and SOC), calculation requirements shall consider current data situation and expected efforts for data collection in relation to quantitative significance of these carbon pools. A Tier 1 or Tier 2 approach according to 2006 IPCC Guidelines may be sufficient for less significant pools.
- Remote sensing and GIS data and analysis shall be used to establish base data, improve efficiency of data collection and to create transparency on stratification and model differentiation (e.g. forest types, climate zones, soil types).

G.2.2 BASELINE

For change reporting and ex-ante modeling of planned activities, a baseline reference for calculation is needed. While this is usually past data for (annual) change reports, more complex baseline scenario models may be necessary for activity-based or prospective reporting.

G.2.2.1 National GHG MRV

For National MRV, the baseline reference to calculate change and ex-post activity impact is the historic situation (stocks and activities). In most cases this is either the data from the previous report (i.e. for annual change reporting) or a (regional) average over a specific historic period (e.g. reporting against a reference stock or emission level). Note that the latter is dynamic by definition and will strongly depend on the spatial and temporal reference chosen. In case of gaps in this baseline data, spatial or temporal interpolation may be used within a reasonable scale.

G.2.2.2 Activity-based and project reporting

Assessing a planned activity or project is not technically part of a national MRV system. However, linking this to the MRV system will facilitate baselining for such endeavors, provide accountability, and allow tracking and later integration in national reporting.

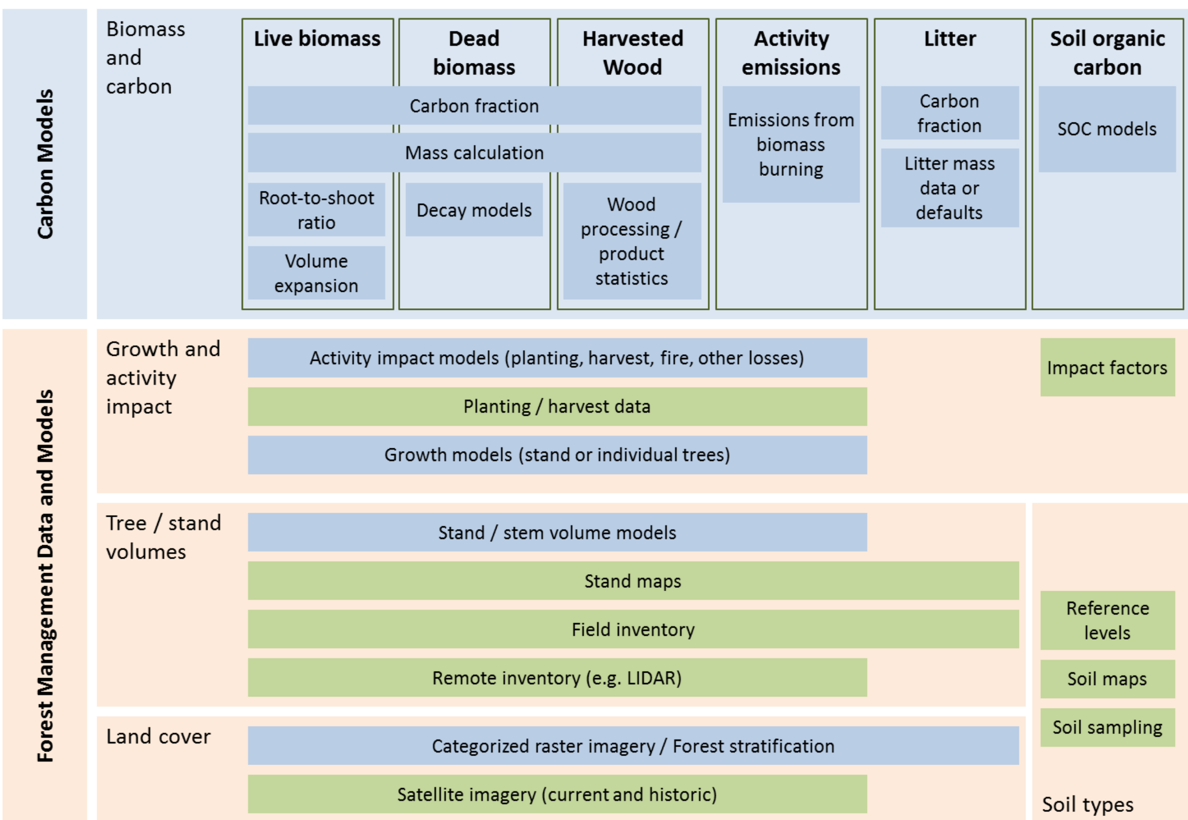
As a general rule, project activity should also consider applying a historic baseline unless significant deviation from this baseline is expected under a “business as usual” scenario. This may be the case in an SFM/IFM (sustainable / improved forest management) project, where a change in practices or management objective is expected and the project intends to improve upon this. An example for this could be a planned infrastructure project and an IFM-driven improvement to reduce loss of (carbon) stock.

Technically, such activity-based baselines are scenario models applying the same structure as used in the BAU models but with a different set of parameters. Thus, scenario models from the DSS (see also section G.1.3 above) may be applied directly for this purpose.

G.2.3 MODEL AND PARAMETER USE

Models and parameters are used to account for forest and carbon stocks and emission in the Turkish Forestry MRV system. Figure G.2-1 below is an overview of models and data used for carbon calculations in the Forestry carbon MRV system. The base data (forest and management) is expected to come out of a forest management tool, specifically the DSS.

Figure G.2-1: Data (green shading) and models (blue shading) used in forest carbon MRV, split between forestry base data (lower part, light red background) and actual carbon calculation (upper part, blue background)



Further models are required to quantify non biomass effects such as activity impacts on Sustainable Development Goals (SDG). Such models need to be specified separately, e.g. based on indicators proposed in section E.3 for SDG accounting).

As a requirement for the MRV, all models and parameters used for (carbon) stock and change calculations must origin from official sources, which includes peer reviewed literature, international guidelines (e.g. UNFCCC/IPCC documentation), as well as nationally accepted methodologies (e.g. from local universities). If forest stock and management data from external systems (e.g. DSS, ORBIS) is used, the respective models have to be transparent and documented.

The following paragraphs specify framework guidelines for data and models for use for the Turkish MRV.

G.3 DATA AND CARBON CALCULATION

G.3.1 BASE DATA AND GROWING STOCK MODELS

As stated above, base data and forest stock models will be defined in the DSS source system. To facilitate MRV link to DSS, the tables in this paragraph provide basic information on data needs, models and potential sources according to information received from GDF stakeholders. Most of the referenced sources are very high level, though, and documentation or original sources were not accessible. For other data requirements, including inventory data source data, key GIS information and remote sensing data, data was not released and no specific sources could be identified due to lack of access to the GDF IT Departments technical staff. Access to data sources will thus be a crucial success factor for DSS/MRV systems and it is likely that the data and model approaches listed in the next paragraphs may have to be adapted once real datasets are connected.

Table G.3-1: Data, models and potential sources for MRV base data

Data / Model	Purpose	Source for Turkey	Remarks
Remote sensing imagery	Use for forest stratification and other analysis, and base image for mapping	*To be clarified with GDF Department of Information Systems*	
Climate zone map	Differentiation of climate zones to develop region-specific models	e.g. Köppen/Geiger classification and map	No information available on current system in Turkey
Soil map	Differentiate soil type for forest stratification and assess soil carbon	Measurements may be necessary to establish SOC_{REF} reference values	No forest-specific soil data available
Forest related GIS data layers	e.g. socioeconomic layer, infrastructure layer, climate/weather data	*To be clarified with GDF Department of Information Systems*	
Land cover / forest classification model	Automatic or semiautomatic analysis of remote sensing data to classify forest types	To be developed in DSS	Potentially to be realized in DSS
Silvicultural stand maps (GIS)	Stand information, activity data,	GDF	Future: ORBIS?
Field inventory data	Individual tree data, i.e. Species, quality/health, DBH, height, crown ratio	ENVANIS (aggregated)	Future: ORBIS?
Growth and management models	Stock development modeling for scenario modeling and growth stock quantification	To be developed in DSS	Will replace the empirical growth and yield tables

	between inventories		
Planting / harvest data	Stand-level information on activities	ENVANIS	
Fire statistics (and risk map)	Fire disturbance data: area, type of fire, loss ratio	GDF Department of Fire combating	
Pest events	Pest disturbance data: area, type of disturbance, loss ratio	ENVANIS	Data is not yet fully available, to be integrated in field inventories
Wood products statistics	Allocation of harvested wood volume to product types	GDF Department of Production and Marketing	

G.3.2 CARBON MODELS

Various models are already used in Turkey and described in previous sections. This paragraph focuses on improvements to calculation of carbon stock in all carbon pools.

G.3.2.1 Above ground and below-ground biomass:

As stated in section F.4.3, improvement potential for carbon quantification in living biomass is in the more specific allocation of parameters, primarily wood density and biomass expansion factor as well as the root-to-shoot ratio. As more detailed empiric data becomes available, development of allometric functions for direct carbon quantification based on inventory parameters should be considered.

G.3.2.2 Dead wood

Field measurement of **standing deadwood** follows the same approach as live tree biomass, with the exception that expansion factors and wood density are reduced depending on level of decomposition. To qualify this, dead tree decomposition class (loss of branches) and state of wood decay ("machete test") are assessed. Depending on decomposition class, normal BEF approach for live biomass is used or a "trunk-only" calculation is applied for volume, and then multiplied with appropriate density. Please refer to Appendix I.

For quantification of **lying deadwood**, a simplified field inventory methodology is used. This approach, in which all lying deadwood >10cm is located on two 50 m transects, diameter measured for each piece, and density assessed with a "machete test".

Refer to the VCS module VMD0002[33] "CP-D Dead wood Version_1" for details (see Appendix I).

[33] http://database.v-c-s.org/sites/vcs.benfredaconsulting.com/files/VMD0002%20CP-D%20Dead%20wood_1.pdf

G.3.2.3 Litter

Depending on the significance of the Litter pool - in most cases this will not be very high – a pragmatic carbon accounting approach should be selected. 2006 IPCC Guidelines provide generic default values (Tier 1) for litter by climate and forest type. This could be improved by using Turkey specific defaults (Tier 2). Only in cases where there is a significant increase (or decrease) in the Litter pool over a relatively short time there may be need for field measurements. For a methodology and guideline to measure litter carbon pool, please refer to section H.3.

G.3.2.4 SOC

Changes in soil organic carbon can be significant, especially when land use change occurs (e.g. after afforestation activities). 2006 IPCC Guidelines provide a Tier 1 approach (Equation 2.25) applying a Soil Organic Carbon reference value (SOC_{REF}), multiplied by a set of stock change factors (for land use, management regime, and organic matter input). However, as the IPCC Tier 1 default values for SOC_{REF} have a nominal error estimate of +- 90% (!), their applicability is rather disputed. On the other hand, Tier 2 approaches applying national, regional or local SOC_{REF} values can be sufficiently accurate. Full field measurements (Tier 3) require relatively high efforts and are usually not performed for normal forestry activities. Nevertheless, should this be desired (or a smaller sample needed to establish SOC_{REF}), Section H.4 provides guideline for SOC field sampling.

G.3.2.5 HWP

Turkey reported HWP based on 2006 IPCC Guideline Tier 1 approach, using relatively coarse product data and a default decay factor (Table 2.1 in 2006 IPCC). If more specific current wood product data can be obtained, this approach, ideally with a more specific decay factor or a more conservative default approach such as the research done by Winjum et. al (1998) and used e.g. in VCS methodology module VMD0026[34] (see Appendix J).

G.4 MRV REPORTING

G.4.1 GENERAL

MRV reporting should follow an integrated reporting approach, combining the underlying data structure with key outputs to meet requirements:

- tables / data access (for analysis and further processing, e.g. for NIR)
- maps / exploratory analysis (for GIS use, publication)
- cockpit reports / scenario “playground” (for presentations, scenario modeling)

The reports should cover requirements listed in Section C.3 but combine data and analysis as far as possible to facilitate development and maintenance. For the same reason, MRV reporting is fully integrated with DSS to access data, models and scenarios.

[34] http://database.v-c-s.org/sites/vcs.benfredaconsulting.com/files/VMD0026%20Estimation%20of%20Carbon%20Stocks%20in%20the%20Long%20Lived%20Wood%20Products%20Pool%2C%20v1.0.pdf

Further, the MRV reporting system should ideally provide

- Web-based access to results to facilitate use by different stakeholders
- Integration for evolving SDG components
- Generally flexible reporting architecture to allow updates and improvements, but always providing a "legacy view" for long-term monitoring

Below paragraphs describe key reports in more detail.

G.4.2 REPORT TABLES

G.4.2.1 GHG inventory report table (national & subnational)

Serving as the data basis for forests in LULUCF reporting, NIR reports should provide outputs supporting the current NIR tables (see section F.5.1). In addition to these data views on a national, overall category level, and the data table should allow drill-down and filtering to review changes at subnational level.

Important in the table report is also the possibility to show a historic data view (at least back to 1990) and listing.

G.4.3 ONLINE MAPS AND GIS INTERFACE

G.4.3.1 Standard map interface (predefined map views)

An online report interface providing a series of pre-calculated set of maps for quick online access could greatly increase the systems uses and user-friendliness. Examples of predefined maps are:

- Carbon stock map
- Sequestration and Emissions map (carbon stock changes), including non-CO2 emissions
- Forest cover map, indicating forest area increase and decrease (and driver for change, e.g. harvest, fire, pests)
- Current "hotspot" map showing areas with largest stock gain and loss, over time

For more advanced user interaction, the portal could provide dynamically assembled maps for custom areas, selection of optional (predefined) information layers and flexible timeline.

G.4.3.2 Interactive mapping and analysis interface (GIS data access)

For advanced and professional mapping and analysis, the system should allow access to MRV data with a GIS tool (e.g. via Google Earth) for in-depth study or custom presentation.

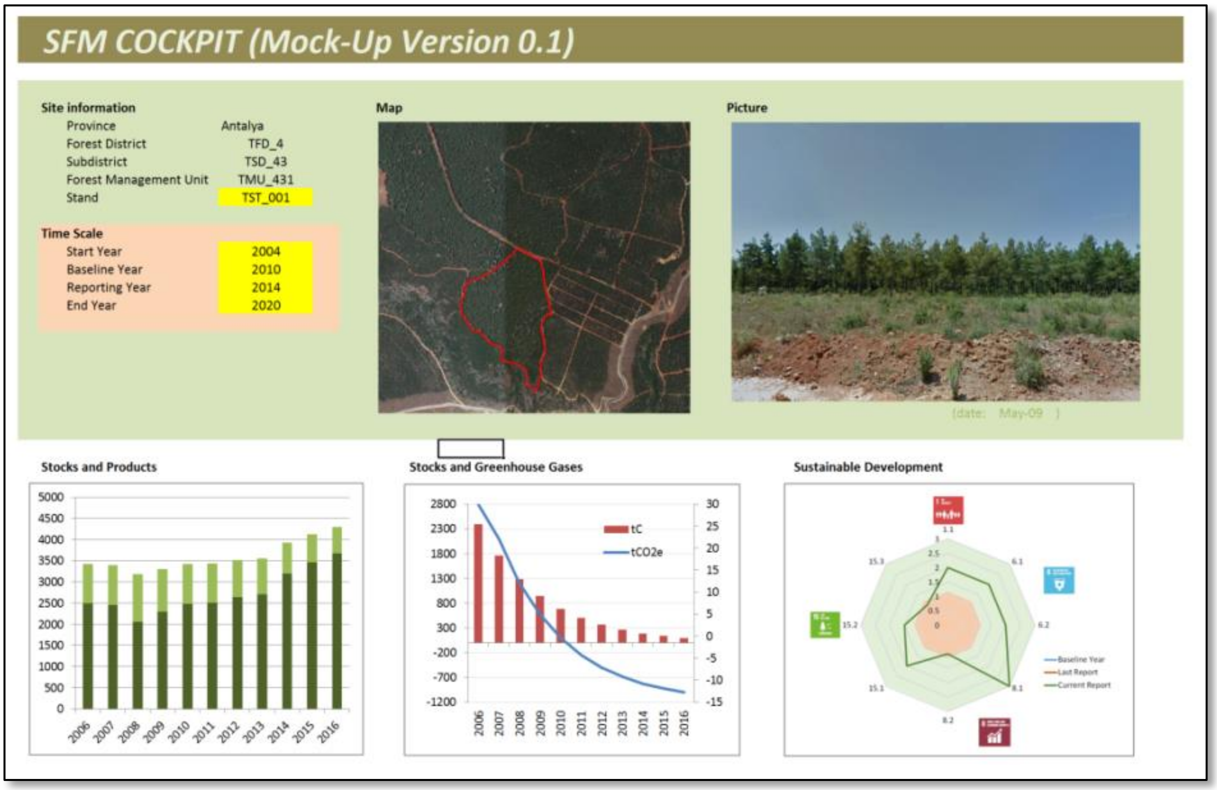
Similarly, as a nice to have function, an online GIS tool (with controlled access) could be set up to allow basic map design and analysis without a GIS client.

G.4.4 COCKPIT REPORT

The cockpit report is the flagship of management reporting. It provides a versatile format with a multitude of information at a glance, and customization options to show e.g. management scenarios or historic comparisons. Key elements envisaged for the MRV/DSS Cockpit are:

- Map view to select area of interest (for which all other data will be shown)
- (Configurable) table showing key information (area, growing stock, carbon stock, species, functions, etc.)
- Bar or pie charts showing stock development and expected products and revenues
- An "SDG radar" chart indicating contributions to Sustainable Development Goals (SDG)

Figure G.4-1: SFM Cockpit Report (Indicative mock-up)



Combining two data views in an MRV cockpit report (e.g. split screen and/or overlay), **changes between two points in time** could be shown, including various impacts thereof.

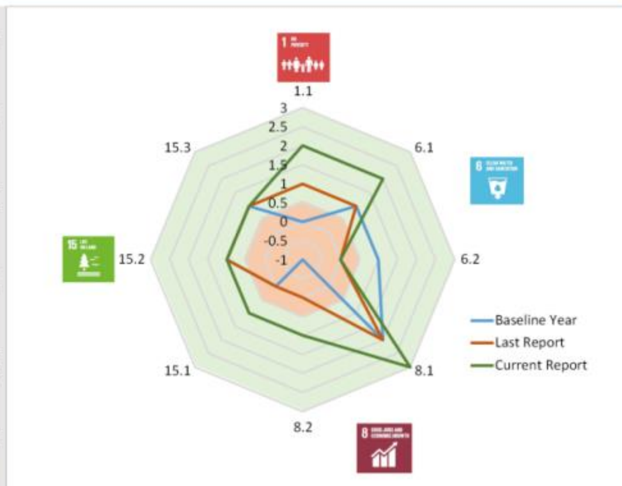
And beyond the actual MRV, i.e. monitoring, reporting and verification, the Cockpit report functionality is also a very useful platform to **compare management scenarios** (as specified in DSS) and their impact on various data (e.g. timber products, value, SDG impacts, etc.)

Using the same architecture with a "business as usual" scenario, a **forecast of stocks** (both biomass and carbon) can be shown. Much like the management scenario views, this could be used to plan future activities.

G.4.5 SDG IMPACT REPORT

In another specialized view, the SDG impact report focuses on contributions of forests and activities to SDGs. It indicates overall **contribution / impact of forestry activities on Sustainable Development Goals** (SDG), showing both quantitative (tabular, trend charts) and visual ("SDG Radar") results.

Figure G.4-2: SDG "Radar" Impact Report (Mock-up – see also Appendix K)



Report Details

Forest Activity Name:	XYZ A/R Nr1
Activity Type:	A/R Timber Harvest
Location:	ABC Nr DEF
Date of Report:	01.07.2016
Monitoring Period:	01/07/2015 - 01/07/2016

Links to wider information at author discretion:
Link to online filing for example

Activity Monitoring

SDG Contribution:	Baseline Year			Last Report			Current Report		
	Indicator	Unit	Score	Indicator	Unit	Score	Indicator	Unit	Score
1.1 No Poverty	10	%	0	9.4	%	1	8	%	2
6.1 Water & Sanitation	10000	Ha cover	1	10000	Ha cover	1	11000	Ha cover	2
6.2 Water & Sanitation	1	Flood event	1	0	Flood event	0	0	Flood event	0
8.1 Economic Growth	0.8	Prod. Index	2	0.81	Prod. Index	2	0.9	Prod. Index	3
8.2 Economic Growth	3	% change	-1	-1	% change	0	5	% change	1
15.1 Life on Land	10000	Ha cover	0	10000	Ha cover	0	11000	Ha cover	1
15.2 Life on Land	4	End. Species	1	4	End. Species	1	5	End. Species	1
15.3 Life on Land	14	%	1	14	%	1	12	%	1

Narrative - Updates since last report

1 - 1000 Ha new planting completed during period

2 - Further updates as relevant

Self-assessment Scoring

3	Significant positive contribution across majority of forest activity area, no significant negative reports
2	Positive contribution across majority of forest activity area, no significant negative reports
1	Minor positive contribution, no significant negative reports
0	Neutral – no impact
-1	Some negative effects witnessed in areas – to be monitored and corrected
-2	Significant negative effects recorded – urgent action required

The SDG impact report could also be integrated in the **Turkish Sustainable Development Report** on a national or subnational level.

G.4.6 CUSTOM REPORTING INTERFACE

In addition to predefined reports and interactive reporting views, a technical access point for (future) tools, e.g. mobile apps, and dedicated reporting systems facilitates use of the MRV data in new environments, or live access from other websites to pull public MRV data.

Technical specification of this interface eventually depends on the system environment the DSS/MRV data base and reporting functions are implemented in. It could range from a programming interface ("API") to a database access for a reporting tool, e.g. BIRT or Jasper Reports (both open source).

PART III: MRV TOOLS

Part III presents the technical guidelines (i.e. measurement techniques, data collection, field protocols, etc.) for the identified missing carbon pools developed for the Turkish carbon MRV system.

This part contains **Section H: Technical Guidelines & Field Protocols.**

SECTION H: TECHNICAL GUIDELINES & FIELD PROTOCOLS

H.1 INTRODUCTION

An important aspect of MRV as stated previously is field data quality, transparency and reproducibility. In order for field inventory data to achieve the desired quality level, standardized measurement and data processing is essential. Chapter H.2 introduces an example for field inventory standard operating procedures, or SOPs. SOPs are a set of step-by-step instructions compiled to help carry out routine operations. They aim at achieving efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with regulations. The following field manual (SOP) is an example of a "lookup booklet" to support inventory field work and to ensure the quality of measurement and data recording. The content overlaps with inventory guidance given in GDF Rescript No. 299 in that it provides (very similar) measurement instructions, e.g. for DBH and height. However, the SOPs in addition also include measurement for deadwood, standing as well as lying.

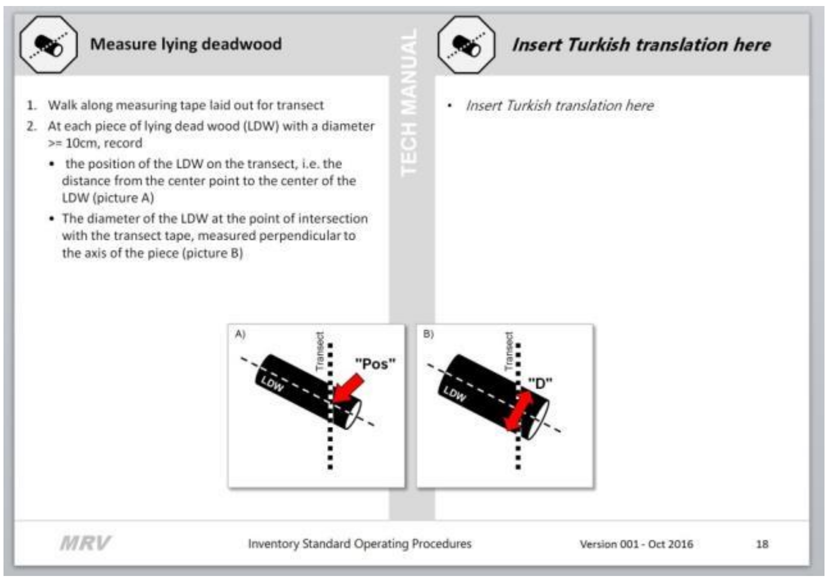
Note that the SOP booklet is not intended to replace proper instruction and regular field training for the inventory teams. Where applicable, more detailed technical manuals should be provided.

For the other missing pools identified in section F.4.3 (namely deadwood, litter and soil organic carbon), general calculations and reporting have been proposed in section G.3.2. And while these approaches are partially based on defaults instead of large scale field data collection, some data may still have to be collected to allow Tier 2 reporting. Paragraphs H.3 and H.4 include references to methodologies for litter and soil carbon quantification while dead wood measurement is addressed in paragraph H.2.

H.2 FOREST INVENTORY STANDARD OPERATING PROCEDURES (SOPS)

The following Standard Operation Procedures (SOPs) are an example for a field booklet providing guidance on measurement approach and techniques (e.g. tree height, diameter, distance, qualitative observations etc.) including measurement of standing and lying deadwood. The approach presented includes clustered sample plot to increase sample data while reducing travel time in the field. The clusters also include a set of transect measurements for lying deadwood. As this is a deviation from the current inventory approach in Turkey, its applicability remains to be discussed – and SOPs are subject to change. The document is attached as Appendix B.

Figure H.2-1: Example of deadwood measurement in MRV SOP



Measure lying deadwood

1. Walk along measuring tape laid out for transect
2. At each piece of lying dead wood (LDW) with a diameter >= 10cm, record
   - the position of the LDW on the transect, i.e. the distance from the center point to the center of the LDW (picture A)
   - The diameter of the LDW at the point of intersection with the transect tape, measured perpendicular to the axis of the piece (picture B)

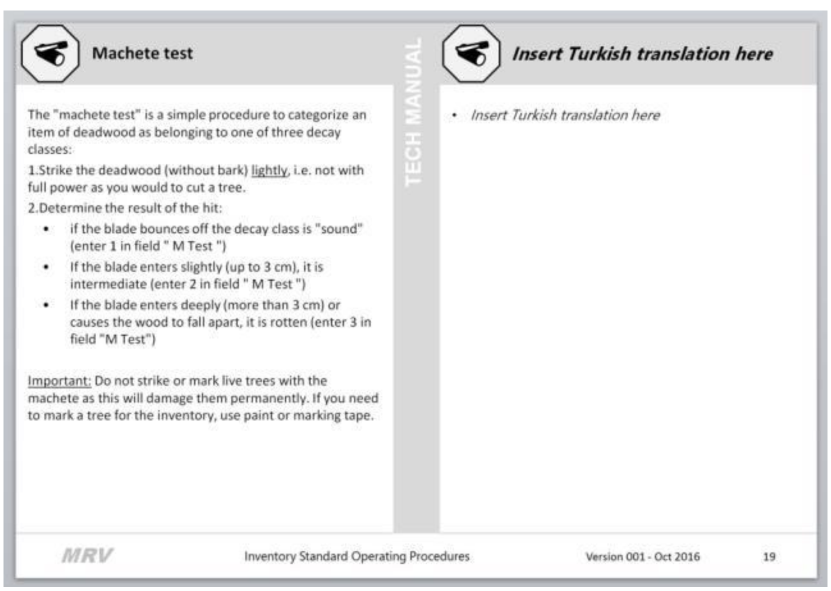
TECH MANUAL

Insert Turkish translation here

- *Insert Turkish translation here*

MRV Inventory Standard Operating Procedures Version 001 - Oct 2016 18

Figure H.2-2: Example of Machete test for deadwood measurement in MRV SOP



Machete test

The "machete test" is a simple procedure to categorize an item of deadwood as belonging to one of three decay classes:

1.Strike the deadwood (without bark) lightly, i.e. not with full power as you would to cut a tree.

2.Determine the result of the hit:

- if the blade bounces off the decay class is "sound" (enter 1 in field " M Test ")
- If the blade enters slightly (up to 3 cm), it is intermediate (enter 2 in field " M Test ")
- If the blade enters deeply (more than 3 cm) or causes the wood to fall apart, it is rotten (enter 3 in field "M Test")

Important: Do not strike or mark live trees with the machete as this will damage them permanently. If you need to mark a tree for the inventory, use paint or marking tape.

TECH MANUAL

Insert Turkish translation here

- *Insert Turkish translation here*

MRV Inventory Standard Operating Procedures Version 001 - Oct 2016 19

H.3 GUIDELINE TO QUANTIFY CARBON STOCKS IN LITTER

In most forests activities, the litter pool is not significant (regarding carbon quantities and change) and thus does not have to be measured. Though in order to develop or confirm default factors, it may be useful to have a standard measurement approach for the litter carbon pool as well. Such data could also be useful to feed into other systems e.g. as fuel data for fire risk models. Also, for A/R activities it makes sense to include litter in carbon stock calculation.

The VCS module VMD0023[35] "Estimation of Carbon Stocks in the Litter Pool, v1.0" provides methods for sampling litter pools for continuous and point source litter types, estimating the total litter biomass within an area and calculating the carbon content of the liter pool. The document is attached as Appendix C.

H.4 GUIDELINE TO QUANTIFY SOIL ORGANIC CARBON

Measurement of soil organic carbon requires careful field collection and considerable lab analysis. As such, SOC is commonly not measured on a large scale as part of carbon inventories, especially as with many forest activities SOC change will not be significant because existing pre-project vegetation (e.g. grass) also has a substantial SOC content (compare chapter A.2). The following activities increasing forest stock may result in a significant change and thus recording would make sense:

- A/R in desert areas
- Restoration of degraded forests

Also, a set of sample sites is useful for calibration of default reference values (SOCref) or confirmation of non-significance.

The VCS module VMD0021[36] "Estimation of Stocks in the Soil Carbon Pool, v1.0" provides the methods to estimate the required number of soil plots in each stratum, design and establish the plots, determine the carbon stock in the soil carbon pool, and check the statistical rigor of the results. Please note that the module is not applicable for sampling or estimation of soil carbon content in organic soils. The document is attached as Appendix D.

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[35] http://database.v-c-s.org/sites/vcs.benfredaconsulting.com/files/VMD0023%20Estimation%20of%20Carbon%20Stocks%20in%20the%20Litter%20Pool%2C%20v1.0.pdf

[36] http://database.v-c-s.org/sites/vcs.benfredaconsulting.com/files/VMD0021%20Estimation%20of%20Stocks%20in%20the%20Soil%20Carbon%20Pool%20v1.0.pdf

H.5 ELECTRONIC FIELD PROTOCOL

Although currently the inventory sheets in Turkey are filled manually on paper in the field an electronic version in Excel format for data input via tablets is provided to show potential for error reduction and efficiency improvement. Compare Appendix E and F. An electronic version provides the possibility to limit data entry to predefined ranges/keys, directly make consistency checks (e.g. not allowing tree height to be entered higher than 100 m), and allows data selection from drop down menus.

PART IV: STAKEHOLDER INTERACTION & TESTING

Part IV presents the Stakeholder Interaction with relevant program participants and key stakeholder at local and international scale and the MRV Field Testing approach and results.

This part is structured in 2 sections:

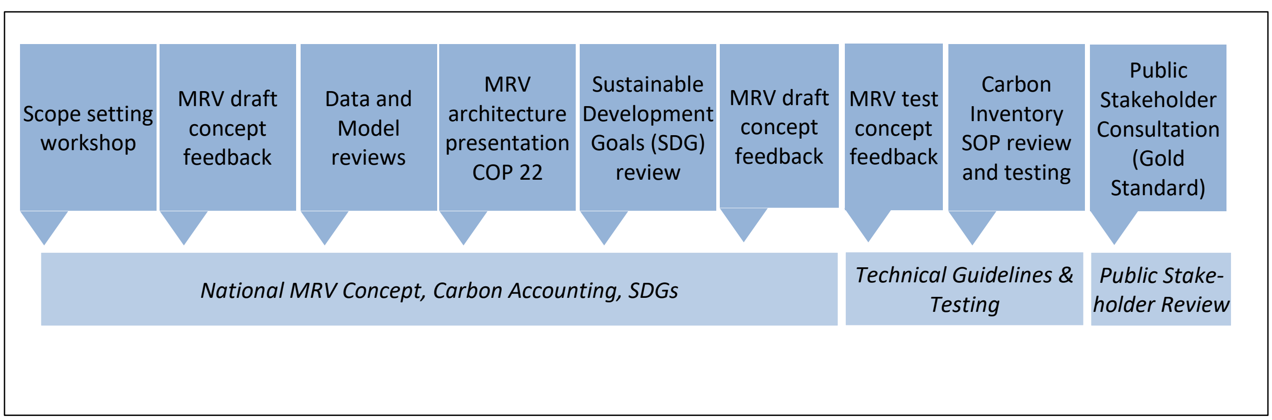
- **Section I: Stakeholder Consultation** describes the stakeholder consultations conducted at different stages of the Turkish MRV design development.
- **Section J: Field Testing** the results and observations gained during field testing of carbon inventory practices to be used in the Turkish forest MRV system

SECTION I: STAKEHOLDER CONSULTATION

I.1 INTRODUCTION

Several stakeholder consultations were conducted at different stages of the Turkish MRV design development to present MRV design ideas and approaches to relevant program participants and key stakeholder at local and international scale. Feedback was collected, discussed and directly integrated during the development process to adapt the MRV design to the Turkish forest situation and international best practice. Figure I.1: outlines the stakeholder events conducted and the following sections provide more information on key stakeholder interaction, events conducted and received feedback in approx. chronological order. Feedback rounds were conducted in several iterations up until final documentation.

Figure H.21: Stakeholder Events Overview



I.2 STAKEHOLDER CONSULTATION EVENTS

I.2.1 SCOPE SETTING WORKSHOP FOR INITIAL DEVELOPMENT AND DEPLOYMENT OF MRV FOR TURKEY'S MEDITERRANEAN FORESTS IN ANKARA IN FEBRUARY 2016

Stakeholders:

The workshop was attended by 27 participants from Turkish government (GDF departments of Combating Forest Pest, Forest Fire Combating, Forest Management and Planning, Information Systems, and Nature Conservation and National Parks; Ministry of Combating Desertification and Erosion), Turkish NGO (Nature Conservation Centre, GSF) and Turkish academia (University of Istanbul, GDF Research Institute for Forest Soil and Ecology) representatives. The workshop was organized by UNDP Turkey, GDF, and TREES and moderated by TREES and Gold Standard.

Outcome/feedback received:

Based on the workshop discussion and feedback received, as well as the post workshop analysis, the following key conclusions were drawn (check detailed summary report of this event[37]):

- MRV scope shall focus on benefits and impacts quantification for afforestation, reforestation/restoration, deforestation, conservation, and sustainable forest management (e.g. improved forest management IFM). To monitor non-carbon benefits, information on biodiversity, environment, non-timber forest products, and SDGs will add value to the MRV system.
- Discussions of data requirements indicate that a considerable amount of data is available but there is uncertainty regarding accessibility, timeliness and data quality. Data collection may be hampered due to lack of coordinating mechanisms between Ministries and Departments.
- Information gaps and shortcomings have been identified around forest stock information, carbon calculation models and parameters, as well as for non-GHG data (e.g. biodiversity or socioeconomics). Solution approaches involving experts to address critical gaps and shortcoming have been proposed.

Figure H.2-1: Scope Setting Workshop Participants

[37] Scope setting workshop for initial development and deployment of the MRV for Turkey's Mediterranean forests. Gold Standard Foundation & TREES Forest Carbon Consulting LLC, March 22, 2016.

I.2.2 FEEDBACK ON MRV DRAFT DOCUMENT

Stakeholders:

Extensive written feedback in comment and track change mode on the first draft version of the MRV document was provided by Prof. Dr. Emin Zeki Baskent and Prof. Yusuf Serengil.

Outcome/feedback received:

Feedback showed clarification potential for carbon terminology and carbon approaches and the need for carbon knowledge capacity building and a regular interaction with relevant program participants and key stakeholders to profit from the local experts to reach the best possible solution customized to the Turkish situation.

I.2.3 DATA AND MODELS REVIEW FOR TURKISH FORESTS

Stakeholders:

TREES developed a detailed data and model questionnaire go gather information on the current Turkish data and model availability for the Turkish forests. Specific questions to assess availability of data, quality of data, data owner and data storage were listed together with model information requests. Several stakeholder rounds and interviews were conducted with the GDF Department of Forest Management and Planning (Mithat Koç, Mehmet Ceylan, Gediz Metin Kocaeli, Yavuz Öztürk, Davut Atar), Department of Information Systems (Selda Taş, Ayten Özdemir), Department of IT (Ibrahim Sanli), Department of Production and Marketing (Ramazan Balı), Foreign Relations, Training and Research Department/ LULUCF Working Group (Uğur Karakoç, Eray Özdemir), and Istanbul University, Faculty of Forestry (Prof Yusuf Serengil).

Outcome/feedback received:

The data and model review revealed broad availability of data. Lack around certain carbon data and models was identified (compare section F of Turkish National MRV System Design report). Also, data and ownership is currently widely dispersed in different departments and systems, sometimes unspecified and access is often difficult. Updates of key information are thus not ensured over time. In addition, data standardization, data processing, data security, and overlaps with ORBIS elements were flagged as an important issue to consider.

I.2.4 MRV ARCHITECTURE OVERVIEW PRESENTATION AT COP 22 IN MARRAKECH IN NOVEMBER 2016

Stakeholders:

GDF, UNDP Turkey (GEF), Gold Standard, TREES, and Yale University presented various topics around the Turkish MRV, SDGs, sustainable forests management, and forest and climate change to an international COP audience. The presentations held included MRV System for Forest Activities in Turkey, Turkey's contribution to SDGs, the Paris Agreement and the studies carried out in the field of forestry in Turkey, optimization of the benefits of forests to climate, as well as outcomes of the project on Integrated Forest Management within the scope of the Paris Agreement.

Outcome/feedback received:
The presentations were well received and questions were directly answered in a Q &A session following the presentations. The audience was very interested to hear when the MRV and SDG system would be implemented and if it could be applied in other countries as well.

Figure H.2-4: Presenters from GDF, UNDP, Gold Standard, TREES, and Yale University at COP 22 in Marrakech

I.2.5 SUSTAINABLE DEVELOPMENT GOALS SDGS REVIEW

Stakeholders:
Feedback on suggested SDG goals, indicators and data was received from the GDF Department of Foreign Relations, Training and Research (Ramazan Balı, Eray Özdemir), Department of Forest Management and Planning (Yavuz Öztürk, Nedim İpek), Department of Forest – Village Relations1 (Kaan Toptan, Ahmet Mete Yüksel), Department of Non-Timber Products and Services (Galip Çağtay Tufanoğlu), Department of Production and Marketing (Kenan Akyüz), UNDP Turkey (Nuri Ozbagdatli), and from Yale University (Prof Chad Oliver).

Outcome/feedback received:
The feedback provided an overview of data and data quality availability but also showed that specific SDG related data are currently not being measured and monitored in relation with forest activities in Turkey. Valuable feedback was however provided on where and how to collect this data and which data would make sense in a Turkish context and in relation with forest activities performed. Prof. Oliver provided detailed improvement idea and proposed practical quantification options for SDG impact measurement and monitoring for specific indicators.

I.2.6 FEEDBACK ON MRV DRAFT DOCUMENT

Stakeholders / Outcome/feedback received:
GDF stated that the final MRV draft document was received well.

I.2.7 MRV TEST CONCEPT FEEDBACK

Stakeholders / Outcome/feedback received:
GDF stated that the final MRV draft document was received well.

I.2.8 CARBON INVENTORY TRAINING PLAN, FIELD PROTOCOLS AND SOP REVIEW AND TESTING

Stakeholders:
Prof Yusuf Serengil (Istanbul University, Faculty of Forestry) provided feedback on the carbon inventory training plan, field protocols and SOP during webinars developed for the carbon field inventory. Participants in field training and testing also had the opportunity to provide feedback and ask questions on the MRV approach and inventory changes.

Outcome/feedback received:
In the measurement guidelines, laser measurements for tree height were introduced and the litter collection instruction updated. During field testing, questions arose around the distinction between litter and lying deadwood.

I.2.9 PUBLIC STAKEHOLDER CONSULTATION ON THE GOLD STANDARD WEBSITE

Stakeholders:
A public international stakeholder consultation on the MRV draft document was held on the Gold Standard website from April 28 to May 19, 2017. The document and the website text were provided both in English and Turkish language and direction were given on how to submit comments. The site was accessible publicly and in addition invitations to review were sent to GDF departments and a link was also published on the UNDP project site.
Outcome/feedback received:
Prof. Chad Oliver (Yale University) provided detailed feedback, mainly on SDG and DSS elements. No further feedback was received, GDF stated that they agree with the MRV design document 1.0.

Figure H.2-9: Screenshot of GS Stakeholder Consultation Website

DESCRIPTION:

Draft MRV document, subject to this consultation, has been prepared in the context of Integrated Forest Management, which is executed by General Directorate of Forestry and is implemented by UNDP Turkey with the financial support of the GEF.

İstişareye açılan taslak MRV dokümanı, Orman Genel Müdürlüğü ile UNDP Türkiye işbirliğinde yürütülen ve Küresel Çevre Fonu (GEF) tarafından finanse edilen Entegre Orman Yönetimi Projesi kapsamında hazırlanmıştır.

***Please note**: this consultation does not concern Gold Standard standards or certification matters*

PERIOD OF CONSULTATION:

28 Apr 2017 to 19 May 2017

OBJECTIVE(S) OF CONSULTATION:

To seek feedback from stakeholders on the draft documentation.

HOW TO SUBMIT YOUR CONSULTATION:

Please submit your feedback to **Turkishforest.consultation@goldstandard.org**

CONSULTATION DOCUMENTATION:

- TÜRKİYE İÇİN ULUSAL İZLEME, RAPORLAMA VE DOĞRULAMA (İRD) SİSTEMİ TASARIMI
- TURKISH NATIONAL MRV SYSTEM DESIGN

SECTION J: FIELD TESTING

J.1 INTRODUCTION

This report describes results and observations gained during field testing of carbon inventory practices to be used in the Turkish forest MRV system. The tests follow the specifications described in the following documents:

- MRV Test Concept[38]
- MRV Carbon Inventory Training Plan[39]

As stated in the MRV test concept, the field tests are set up to assess practicability, data quality and usability for the forestry MRV system, ensuring accurate measurements which are key to a high-quality MRV system. Core objectives are

- confirmation of applicability of the inventory approach as specified in the MRV design document and the inventory standard operating procedures (SOP), and
- assessment of measurement quality and bias (data reviews after the field measurements).

J.2 TEST SCOPE

The test details are specified in test cases 2-01, 2-02, 2-03, 3-01 and 3-02 (compare Table J.2-1) described in the MRV test concept (also listed in chapter J.11). Note that test case 3-03 (model application) was not executed as no models have been selected for the DSS yet.

Table J.2-1: Overview of test cases for MRV system including test category and test type

No.	Test Category	Type	Test Case
2-01	Field inventory practices	Documen-tation test	Training and Documentation: Completeness and applicability
2-02	Field inventory practices	Field testing	Field measurements: SOP efficiency and effectiveness, measurement techniques, data recording
2-03	Field inventory practices	Field testing	Data collection: database entry
3-01	Field inventory data	Data review	Measurement accuracy: analysis of repeat measurements
3-02	Field inventory data	Data review	Data quality: completeness, distribution, outliers and inconsistencies (raw data)
3-03	Field inventory data	Data review	Data applicability (system independent): sample model runs

[38] Test Concept Turkish National MRV System Design, v 1.0, Prepared by TREES Forest Carbon Consulting LLC December 22, 2016
[39] Carbon Inventory Training Plan, Turkish National MRV System Design v1.0, Prepared by TREES Forest Carbon Consulting LLC, January 18, 2017

J.3 PARTICIPANTS

J.3.1 PARTICIPANT REQUIREMENTS

To facilitate a focused MRV inventory training and testing, field inventory participants were expected to

- have practical forest inventory experience (field work and possibly data processing),
- have the ability to learn the extended inventory concept, including its rationale,
- have the ability and capacity to train further staff based on the training and documentation provided.

J.3.2 PARTICIPANT LIST

For the field training and testing, 9 inventory staff (six experts from GDF/forest service and three graduate students from Istanbul University) were invited and grouped in three field teams (list of field test participants is available from Prof. Yusuf Serengil).

J.4 TEST SITES

J.4.1 SITE REQUIREMENTS

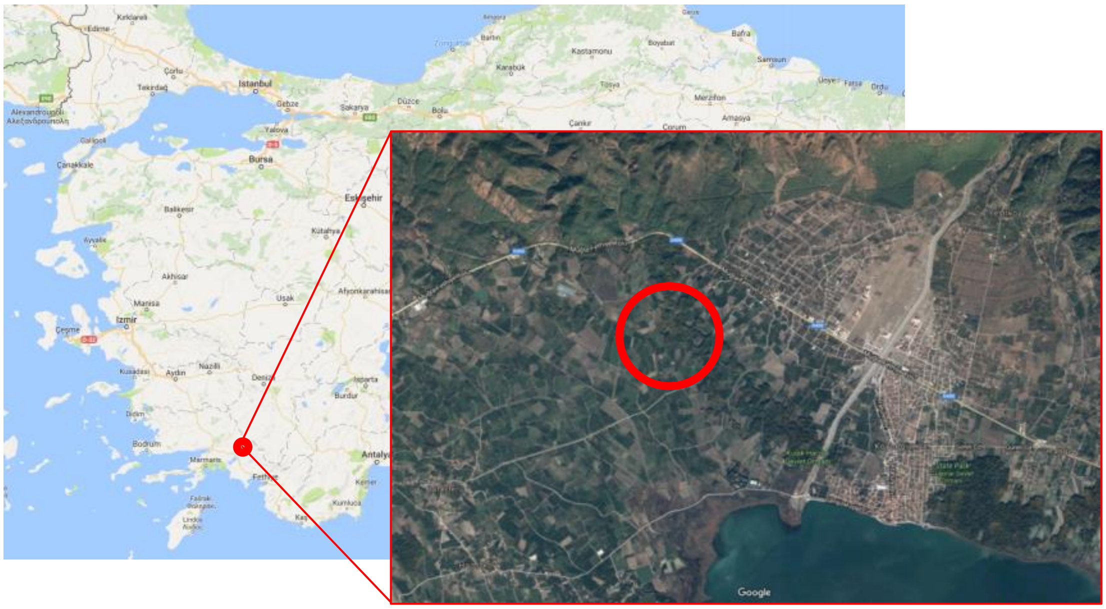
The MRV test concept lists the following requirements for the test sites:

- Each site must have large enough forest area to establish three circular sample plots (radius 11.26m to 15.96m, depending on crown closure)
- Sites should vary in forest type / structure (species, crown closure, undergrowth, degradation, age, …) and possibly terrain forms (slope)
- At least one site should include standing and lying dead wood
- All sites should be well accessible to facilitate transfer

J.4.2 SELECTED SITES

Based on above requirements, UNDP Turkey/GDF selected a set of managed forest stands near Köyceğiz (Muğla Province).

Figure J.4-1: Location of field training and testing sessions:



J.5 APPROACH AND SCHEDULE

A structured test schedule (see table J.5-1) was established to ensure that an adequate amount of data is collected to assess applicability of the inventory approach.

Participants were split into three field teams (3 persons per team). In each site, a set of sample plots were established (two for day one and three for day two), to be measured by multiple teams (in sequential "rotations"), the re-measurement of plots allowing identification of measurement bias and potential measurement issues.

Table J:5-1: Field testing schedule

Day 1	Day 2
Pre-inventory training / Q&A session	Transfer to test site 2
Transfer to test site 1	Rotation 1: setup and measurement of a sample plot per team
Rotation 1: setup and measurement of a sample plot per team	Rotation 2: teams rotate between sample plot and re-measure
	Rotation 3: teams rotate between sample plot and re-measure
Rotation 2: teams rotate between sample plot and re-measure	Collection of data (inventory protocols) and feedback
Collection of data (inventory protocols) and feedback	Wrap-up, collection of lessons learned
Return transfer	Return transfer

J.6 PRE-INVENTORY TRAINING

Two training documents were prepared for the pre-inventory training:

1) Forest MRV Inventory Training[40] – Introduction: to educate participant on importance of field inventory and changes/additions needed to establish solid MRV base data.
2) Forest & Carbon Inventory Standard Operating Procedures SOP[41]: a field booklet with step-by-step instructions for all relevant field inventory activities.

Both documents were produced by TREES / Gold Standard in English and translated to Turkish for use in the training sessions. Trainings were held by Professor Yusuf Serengil of Istanbul University.

Before the field inventory activities, an introductory training session was held by Professor Yusuf Serengil of Istanbul University to familiarize the field teams with new carbon inventory extensions added to the current forest inventory approach.

The training covered the following three topics, based on the documentation provided (examples in figures J.6-1 and J.6-2):

(i) Introduction to MRV and data requirements from field inventory
(ii) Presentation of proposed extensions to forest inventory activities to meet MRV requirements, based on current inventory approach (as described in Rescript No. 299)
(iii) Introduction to field inventory testing (objectives, approach/test cases, schedule)

[40] Turkish National MRV: Forest Carbon Inventory Training Webinar ppt by TREES Forest Carbon Consulting March 2017

[41] Forest & Carbon Monitoring Field Booklet Inventory Standard Operating Procedures SOP, v002, March 2017 by TREES Forest Carbon Consulting LLC

Figure J.6-1: Example slide from MRV Introduction presentation (English version)

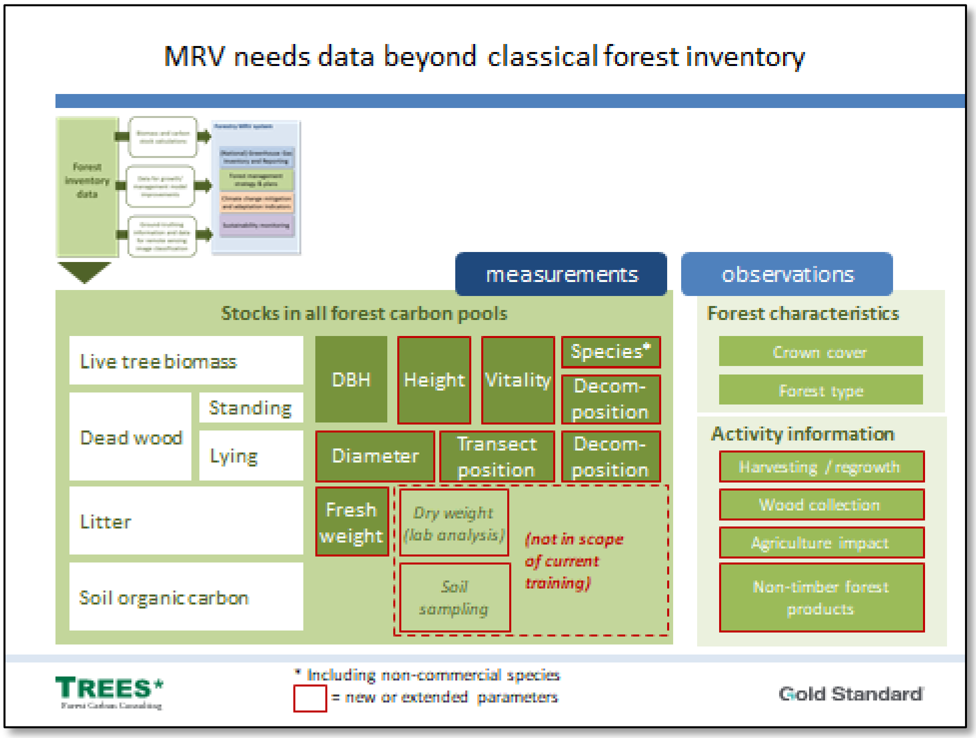
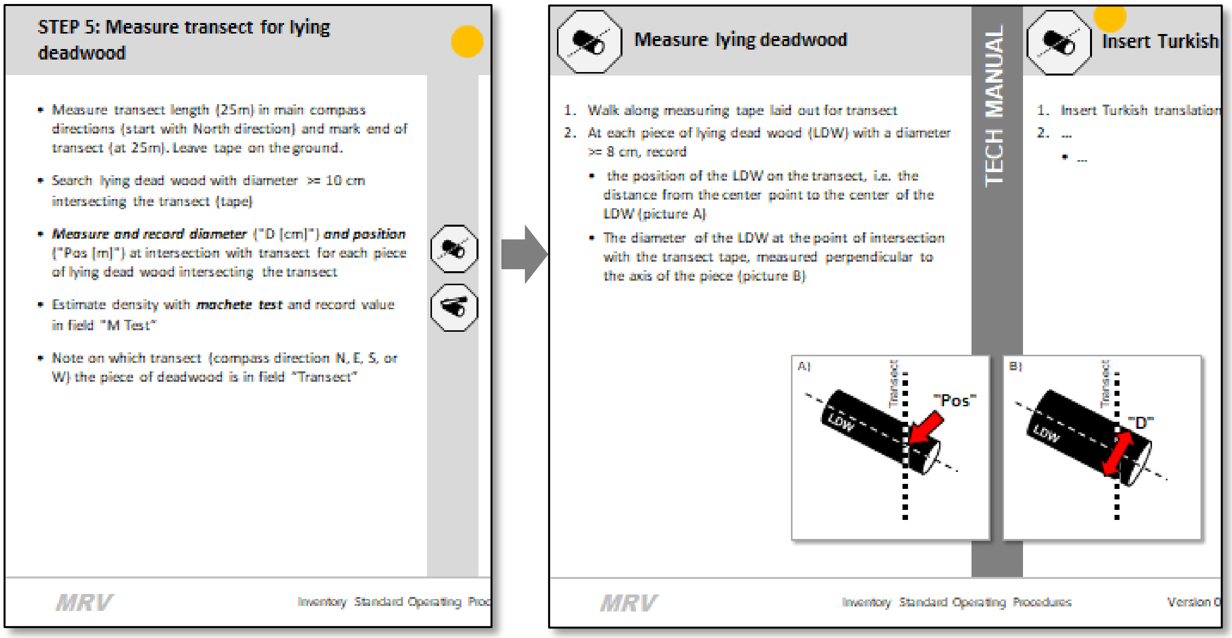


Figure J.6-2: Example pages from Field Inventory SOP Manual booklet (English version)



J.7 RESULTS: TEST CASE SUMMARIES

The following tables summarize the test outcomes according to the test cases. References are provided to the detailed results in sections J.9.

J.7.1 TEST CASE 2-01: TRAINING AND DOCUMENTATION: COMPLETENESS AND APPLICABILITY

Test Steps	Expected Result (for each step)	Result	Comment
1. Review SOP for completeness and applicability	SOP complete	ok	
2. Apply SOP in field training and testing (test case 2-02)	Training based on SOP successful	ok	
3. Collect feedback on documentation	Feedback collected	ok	

J.7.2 TEST CASE 2-02: FIELD MEASUREMENTS: SOP EFFICIENCY AND EFFECTIVENESS, MEASUREMENT TECHNIQUES, DATA RECORDING

Test Steps	Expected Result (for each step)	Result	Comment
1. Go to sample plot coordinates and set up center and perimeter	Sample site found and correctly marked	**Not ok**	Variations in recorded plot coordinates as well as differing tree counts indicate need for harmonization between inventory teams (see section J:9.1 and J.9.2)
2. Measure standing tree parameters according to SOP	All tree parameters measured correctly	**Not ok**	Results indicate shortcomings in application of SOP and lack of diligence in results documentation (see section J.9.2)
3. Measure lying dead wood according to SOP	Transects installed correctly and lying dead wood measured	ok	Test to be repeated due to lack of lying dead wood in sample sites (see section J.9.3)

4. Collect litter sample according to manual	Litter sample collected correctly and ready for transport	ok	

J.7.3 TEST CASE 2-03: DATA COLLECTION: DATABASE ENTRY

Test Steps	Expected Result (for each step)	Result	Comment
1. Check field protocols for completeness and assess documentation quality	Field data complete	n/a	No feedback was received on field protocols and data transfer procedure. See test case 3-01 and 3-02 for content quality.
2. Enter all data from field inventory to database or datasheet (manual)	Field data entered in database (or datasheet)	n/a	

J.7.4 TEST CASE 3-01: MEASUREMENT ACCURACY: ANALYSIS OF REPEAT MEASUREMENTS

Test Steps	Expected Result (for each step)	Result	Comment
1. Check completeness of data	Data entered	**Not ok**	Data gaps were identified (see sections J.9.1ff)
2. Check statistical distribution for bias and outliers	No bias or outliers	ok	Due to large variance in height measurements, bias cannot be entirely dispelled. Nevertheless, no statistically significant bias or extreme outliers were identified.
3. Check for erroneous/inconsistent data (“sanity check” for e.g. overly high trees or unreasonable height-to-DBH ratio)	No inconsistent data	**Not ok**	Various data errors were identified (see sections J.9.1ff)

J.7.5 TEST CASE 3-02: DATA QUALITY: COMPLETENESS, DISTRIBUTION, OUTLIERS AND INCONSISTENCIES (RAW DATA)

Test Steps	Expected Result (for each step)	Result	Comment
1. Test statistical significance of differences between measurement runs and teams	Statistical test completed - no significant differences	**Not ok**	For height measurements, significant differences between repeated measurements were found (see section J.9.2)

7.6 TEST CASE 3-03: DATA APPLICABILITY (SYSTEM INDEPENDENT): SAMPLE MODEL RUNS

Test Steps	Expected Result (for each step)	Result	Comment
1. Load data into test environment (inventory data plus additional data as needed for models)	Data loaded	n/a	No modeling environment was available at time of testing
2. Run model calculations	Model run successful (no errors)	n/a	
3. Assess model outputs	Outputs consistent and within expectations	n/a	

J.8 RESULTS: TEST EXECUTION AND PROTOCOLS

J.8.1 FIELD ACTIVITY

Field tests were executed according to schedule: On the first day 3 points were measured twice by different groups (blue, red and white). The second day 3 points were measured 3 times by the same 3 groups. From feedback and observations during the test activity, the following issues were reported:

- Definition of litter and lying deadwood pools: In the current version, there is a gap in accounting for (woody) biomass on the ground. Litter covers small debris up to 2 cm in diameter; lying Deadwood is measured from a diameter of 10 cm upwards (in accordance with the minimum diameter for standing live and dead trees. This approach conservatively omits woody debris between the two categories. Solution proposed by the field teams is to increase maximum diameter for the litter sampling to 10 cm to close the gap.
- Quantity of lying dead wood: Observations in the test sample plots indicated that very little lying deadwood is present in the test sites, which was confirmed by the very limited sample data, preventing quantitative analysis (see section J.9.3).
- Height measurements were observed not to be performed consistently. Possibly due to a perception of height measurement being too cumbersome, tree height might have been estimated only, similar to current practices in Turkish forest inventory. This is corroborated by the test inventory results (section J.9.2.2).

J.8.2 DATA RECORDING AND PROTOCOLS

Data was recorded on paper-based field protocols and subsequently transferred manually into the respective Excel spreadsheets. An initial review of the data in the spreadsheets identified various formatting, quantitative and assumed naming errors. Where possible, these errors were corrected on a best estimate basis as described in table J.8-1.

Table J.8-1: Identified data errors and corrections (where applicable)

Data source (Sheet)	Data field / record	Erroneous value	Corrected value	Comments
FD1_blue	Plot No	FD3	FD1	Corrected based on sheet name and data distribution
FD3_blue	Plot No	FD1	FD3	Corrected based on sheet name and data distribution
SD2_white	Plot No	SD2	SD3	Corrected based on data distribution
SD3_white	Plot No	SD3	SD2	Corrected based on data distribution
SD1_blue and SD1_red	Species Code	Various invalid codes	1	Corrected based on species name in same recordsets (“Pinus nigra”)
SD2_red, SD2_white, SD3_blue, SD3_red, SD3_white	LDW: Pos.(m) or D (cm)	invalid data in one or more fields	0	
SD3_blue	Radius [m]	11:45	11.45	Typo /formatting error
FD2_red	X coord	64690	unknown	uncorrected
FD2_white	Wet weight	0.81	unknown	uncorrected
All	Observation fields (data)	Incorrect values	Values as selected in “radio buttons” in Protocol	Potential copying error in field protocol file.

J.9 RESULTS: INVENTORY DATA

J.9.1 SAMPLE PLOT INFORMATION

J.9.1.1 Coordinates

Distances between plot centers calculated from coordinates registered on the protocols by different teams vary between 5 and several hundred meters. In two instances, coordinates even deviate by several kilometers (marked red in table J.9-1). Mean distance not considering the very large deviations is 271m.

Table J.9-1: Coordinates recorded by team (very large deviations marked red)

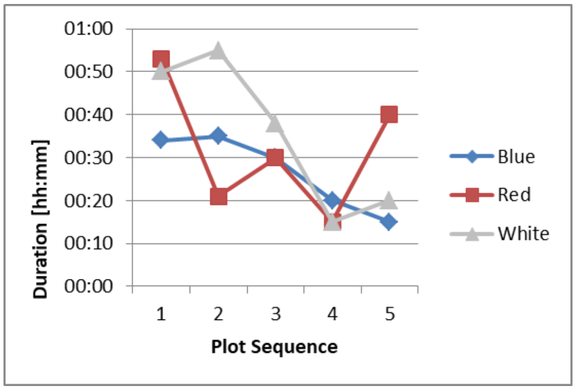
Plot	Coordinates recorded by team						Calculated distance [m]		
	Blue		Red		White		Blue-Red	Blue-White	Red-White
	X coord	Y coord	X coord	Y coord	X coord	Y coord			
FD1	646758	4095218	646807	4095396			185		
FD2			64690	4095313	646866	4095133			582176
FD3	646887	4095167			646893	4095160		9	
SD1	647347	4095337	647380	4094548	647337	4095366	790	31	819
SD2	647275	4095407	647325	4095596	647081	4098505	196	3104	2919
SD3	647360	4095420	647411	4095617	647365	4095420	203	5	202

J.9.1.2 Sampling time

Sampling times for a sample plot varied from 15 to 50 minutes, with a decreasing trend as sampling proceeded. Some of the very short measurement times representing less than 1 minute per tree may also indicate quality issues in the field work (e.g. with height measurements, see section J.9-2)

Table and Figure J.9-2: Sampling time (duration) by team

Plot	Duration by team [hh:mm]		
	Blue	Red	White
FD1	00:35	00:53	
FD2		00:21	00:50
FD3	00:34		00:55
SD1	00:30	00:15	00:15
SD2	00:20	00:40	00:38
SD3	00:15	00:30	00:20



J.9.1.3 Forest Type

Forest type recorded by teams varied both in type and crown closure (Table J.9-3).

Table J.9-3: Forest type recorded by team

Plot	Forest Type	Column Labels		
		Blue	Red	White
FD1	Sğcd3		X	
	Sğd1b3	X		
FD2	Sğc3		X	
	Sğcd3			X
FD3	Sğbc3	X		
	Sğc3			X
SD1	Çzd2		X	
	Çzd3	X		X
SD2	Çzc3	X	X	X
SD3	Çzcd3	X	X	
	Çzd3			X

J.9.1.4 Gradient and Plot Radius

Gradient measurements (relevant in plots SD2 and SD3) varied considerably. Radius adaptation was performed accordingly, including an increased plot radius for SD1 by team Red corresponding with their estimate of crown closure (see above).

Table J.9-4: Gradient and plot radius recorded by team

Plot	Gradient			Plot radius by team		
	Blue	Red	White	Blue	Red	White
FD1	0	0		11.28	11.28	
FD2		0	2		11.28	11.28
FD3	0		3	11.28		11.28
SD1	0	0	0	11.28	13.82	11.28
SD2	35	30	40	11.53	11.53	11.71
SD3	25	38	30	11.45	11.67	11.53

J.9.1.5 Observations and Comments recorded

Observations recorded by team are incomplete and vary between teams.

Additional instructions need to ensure that such qualitative information is recorded accurately as well - e.g. for SDG impact assessment - and that guidelines for observations including definition of area relevant for observations are established and communicated to field inventory teams.

Table J.9-5: Observations recorded by team. Yellow fields indicate missing data, red field inconsistencies

Plot	Observation Categories	Observations by tem		
		Blue	Red	White
FD1	Fire	none	none	
	Pastoral use	none	none	
	Agricultural use	none	none	
	Buildings and trails	none	none	
	Small scale wood collection	none	none	
	Logging	none	none	
	Undergrowth/Regrowth	none/little	none/little	
FD2	Fire		none	none
	Pastoral use		none	none
	Agricultural use		none	none
	Buildings and trails		none	<50m
	Small scale wood collection		none	recent
	Logging		none	none
	Undergrowth/Regrowth		none/little	none/little
FD3	Fire	none		none
	Pastoral use	none		none
	Agricultural use	none		none
	Buildings and trails	<50m		<50m
	Small scale wood collection	recent		none
	Logging	*n/a*		none
	Undergrowth/Regrowth	None/little		some
SD1	Fire	*n/a*	*n/a*	*n/a*
	Pastoral use	*n/a*	*n/a*	*n/a*
	Agricultural use	*n/a*	*n/a*	*n/a*
	Buildings and trails	*n/a*	*n/a*	*n/a*
	Small scale wood collection	*n/a*	*n/a*	*n/a*
	Logging	*n/a*	*n/a*	*n/a*
	Undergrowth/Regrowth	*n/a*	*n/a*	*n/a*
SD2	Fire	*n/a*	none	none
	Pastoral use	*n/a*	none	none
	Agricultural use	*n/a*	none	none
	Buildings and trails	*n/a*	none	>50m
	Small scale wood collection	*n/a*	none	>2years
	Logging	*n/a*	none	>2years
	Undergrowth/Regrowth	*n/a*	none/little	none/little
SD3	Fire	none	none	none
	Pastoral use	none	none	none
	Agricultural use	none	none	none
	Buildings and trails	>50m	none	>50m
	Small scale wood collection	none	none	>2years
	Logging	none	none	>2years
	Undergrowth/Regrowth	none/little	none/little	none/little

J.9.2 STANDING TREES

J.9.2.1 DBH

DBH measurements for standing trees show acceptable conformance in distribution. Figure J.9-6 (left image column) shows DBH for individual trees (sorted by DBH) as measured by each team per plot. Notably, tree counts for all plots except FD2 vary between the teams. Such differences should be correlated to the different plot sizes selected by the teams (due to different perception of crown cover and plot gradient – see section 8.1.4. above). However, plot size cannot account for all differences: in almost all sample plots, differences are present despite having selected the same plot radius, in some cases even going against the plot size effect (i.e. teams with smaller sampling areas are counting more trees than teams with larger sampling areas).

For future inventory activities, it is crucial to improve sampling quality, including decision criteria for individual tree inclusion or exclusion (e.g. along edges of sample plot) as describe in inventory standard operating procedures (SOP). Training sessions with repeated measurements on identifiable trees (e.g. with numbered trees or additional documentation of tree position) can better identify and quantify bias between teams.

J.9.2.2 Height

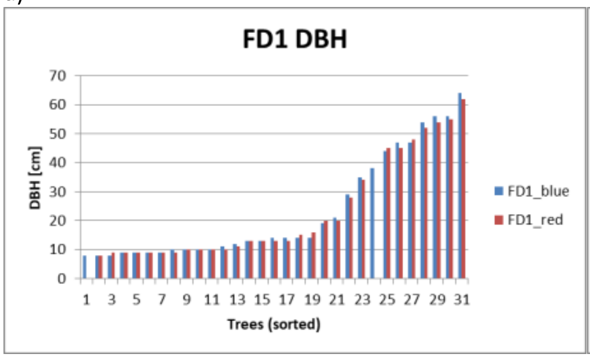
Height measurements (Figure J.9-6, right column) show considerable variance. Diagrams in figure J.9-6 as well as non-parametric statistical tests (Mann Whitney test and Wilcoxon signed rank test – see table J.9-7) indicate significant differences between teams' height measurements for all sample plots.

While it is common for height measurements to have higher variation than diameter, e.g. due to limited visibility of tree tops from ground level, the significant differences across almost all measurements and teams in this test inventory indicate sampling issues.

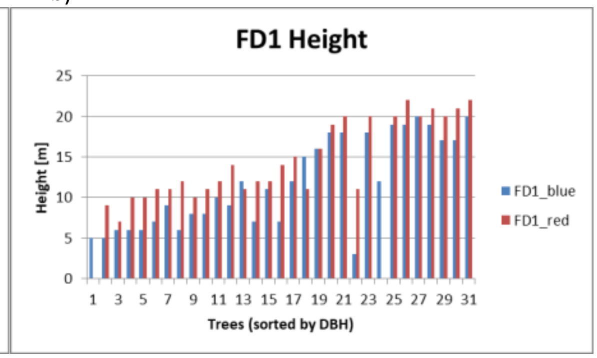
Accurate data on height of individual trees is a crucial data requirement for most modern volume and growth models and it is not sufficient for MRV inventory activities to rely on estimates for tree height (stand level or individual trees). It is thus strongly recommended that field teams are re-trained in height measurements applying all relevant techniques (e.g. laser measurement tools as well as traditional distance and angle measurements).

Figure J.9-6: Standing tree measurements by each team for plots FD1 through SD3. Left column shows DBH (figures a,c,e,g,I,k), right column shows height (figures b,d,f,h,j,l)

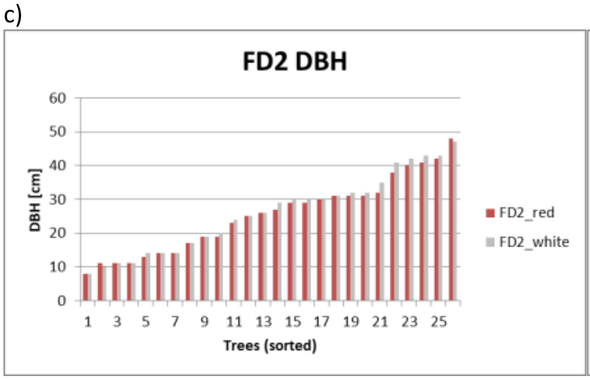
a)



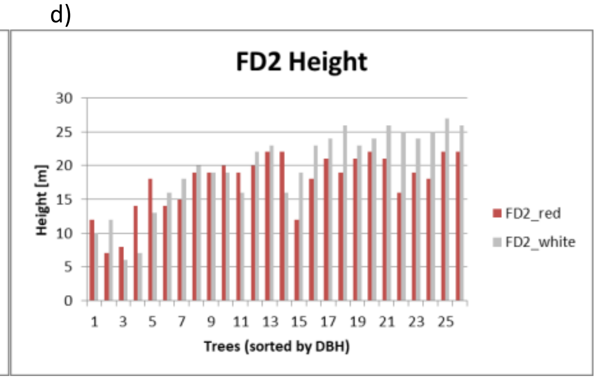
b)



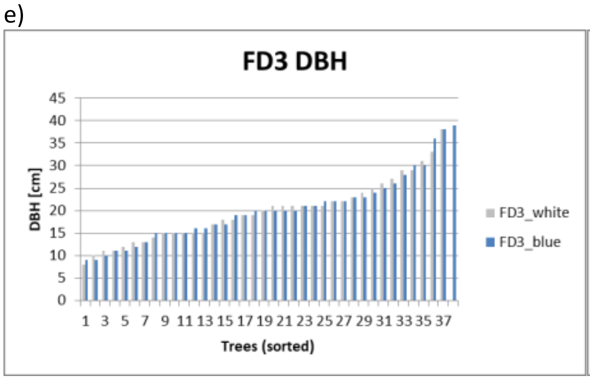
c)



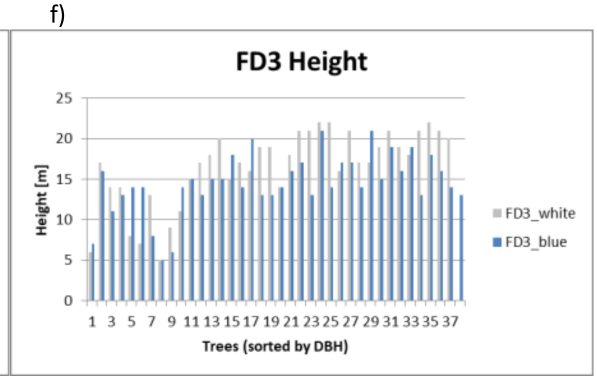
d)



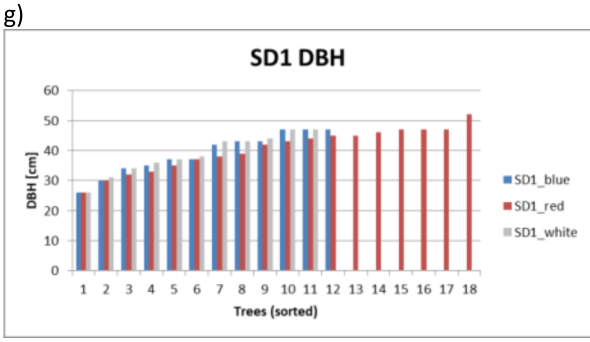
e)



f)



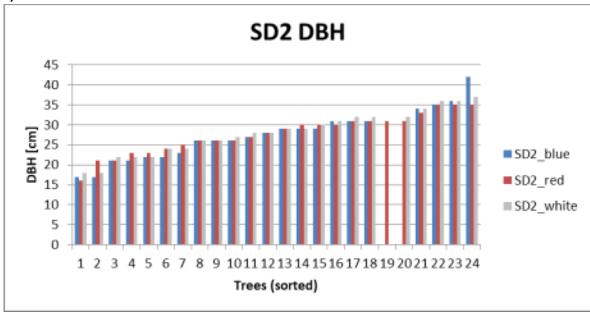
g)



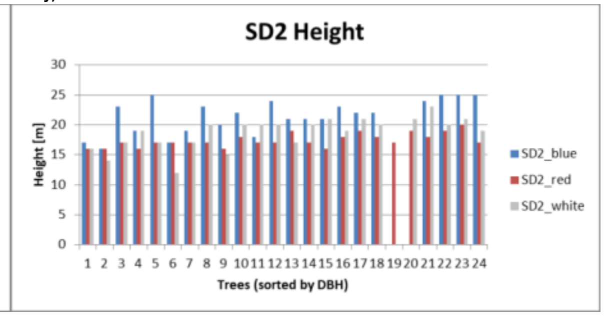
h)

Table J.9-6 (continued)

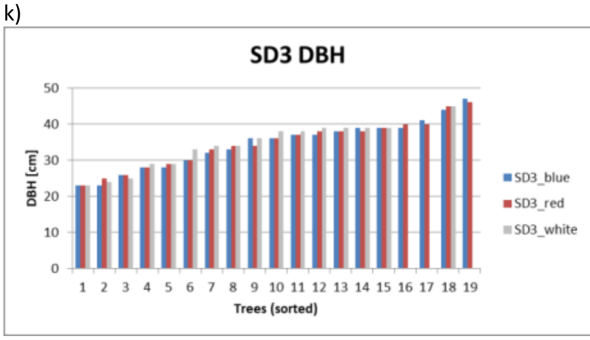
i)



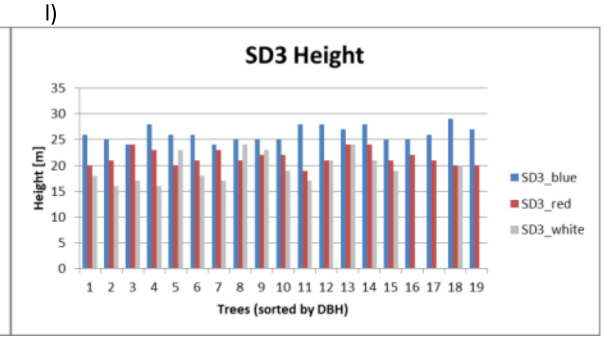
j)



k)



l)



J.9.2.3 Statistical results for DBH and Height

To assess inventory quality in more detail, results from first day inventory (plots FD1 to FD3 were analyzed statistically. As direct tree mapping was not done in the test inventory, i.e. teams had no instruction to measure trees in same order or to record exact tree position, comparison of sorted DBH values and assessment with a non-parametric test (Mann Whitney rank sum test) was applied.

For DBH measurements, differences are non-significant and less than 1cm on average. Thus, quality is considered adequate for carbon inventory.

For Height measurements, average differences between teams are several meters and in two out of the three sample plots, differences between samples are statistically significant (despite being measured on the same plot). This clearly indicates shortcomings in the measurements.

Table J.9-7: Results statistical test results for plots FD1 to FD3

Plot	DBH		Height	
	Mean difference (ordered)	Mann Whitney Test P-value (two-sided)	Mean difference (ordered)	Mann Whitney Test P-value (two-sided)
FD1	0.34 cm	0.952 **ns**	-2.62 m	0.0172 *
FD2	-0.69 cm	0.765 **ns**	-1.88 m	0.0708 **ns**
FD3	0.07 cm	0.884 **ns**	1.41 m	0.0070 **

J.9.3 LYING DEADWOOD

Only one piece of deadwood was recorded within the test sample plots with a diameter of ~10cm (corresponding to a carbon mass of 0.1 tCO2eq/ha), strongly indicating that the lying deadwood carbon pool is insignificant.

No further analysis was performed. However, it is strongly recommended to conduct additional training for this inventory activity in an area with more lay lying deadwood assessment as these practices are not usually done in traditional forest inventories and teams will thus not have the experience and routine needed to ensure efficient and accurate field sampling.

J.9.4 LITTER

For litter sampling, basic collection and measurement was tested by the field teams. Results in table J.9-8 show expected variation in measured sample weight with one obvious recording error (marked red in table). Mean standard error (MSE) for litter sample weights is mostly below 10% with one exception of 19%. While the latter is rather on the upper limit for carbon monitoring, it can still be considered acceptable as mean standard error decreases with sample size (which will be significantly larger in any MRV monitoring activity).

Table J.9-8: Litter sample weights (g) as recorded by field teams

Plot	Team			Analysis		
	Blue	Red	White	Mean	MSE	MSE %
FD1	1060	1015		1038	16	2%
FD2		1550	0.81	n/a	n/a	n/a
FD3	1255		1040	1148	76	7%
SD1	1360	1300	1530	1397	56	4%
SD2	1320	1329	2510	1720	323	19%
SD3	1770	2180	2540	2163	182	8%

J.9.5 SOIL

In accordance with the training and testing plan, no soil sampling was performed as this requires specialized equipment and training. A standard soil sampling and data approach for Turkey is currently being set up in a separate initiative led by Prof. Yusuf Serengil.

J.10 TEST CONCLUSIONS

J.10.1.1 Test case results summary

Out of the six test cases, three resulted at least partially in unsatisfactory results. For MRV implementation, improvement measures need to be taken.

Table J.10-8: Test case results summary

Test Case	Test Case title	Result	Comments
2-01	Training and Documentation: Completeness and applicability	Ok	
2-02	Field measurements: SOP efficiency and effectiveness, measurement techniques, data recording	Not ok	Quality of field work needs improvement: plot identification/coordinates, plot delineation (tree count), tree height measurements
2-03	Data collection: database entry	n/a	No feedback was received on field protocols and data transfer procedure
3-01	Measurement accuracy: analysis of repeat measurements	Not ok	Data partially incomplete, data recording / transfer errors
3-02	Data quality: completeness, distribution, outliers and inconsistencies (raw data)	Not ok	Tests indicate significant differences between tree height measurements (repeated measurements by separate teams)
3-03	Data applicability (system independent): sample model runs	n/a	No modeling environment was available at time of testing

J.10.1.2 Conclusions by carbon pool

The following paragraphs summarize test outcomes by their impact on monitoring and reporting for forest strata and relevant carbon pools. As no test data was collected for below ground biomass (BGB), harvested wood products (HWP) and soil organic carbon (SOC) pools, these pools are not listed. However, as BGB and HWP are commonly calculated from or at least linked to AGB the conclusion stated below indirectly also affect these carbon pools. For each pool, actions are proposed to improve quality and ensure accurate MRV data.

Stand characteristics / forest classification (inventory stratum)

Outcome:	• Variation was observed in forest type classification and crown closure assessment. As these factors impact area stratification and sampling accuracy, it is important that they be considered equally important as other field inventory data.
Actions required:	• Trainings for inventory need to include section repeating forest type criteria and crown cover estimation. • Inventory analysis by forest type should be performed to identify and potentially correct misclassifications.

Above ground biomass (AGB)

Outcome:	• Due to lack of an updated model, biomass calculations were not performed as part of the tests. However, as most up-to-date models, especially for mixed species stands, include individual tree height as an important parameter, the shortcomings in both tree count (i.e. trees measured per plot) and tree height measurements are critical. Any report or representation calculated on such inadequate data lacks accuracy and thus credibility, significantly reducing the value of even the most sophisticated MRV tools.
Actions required:	• Training on tree measurement procedures, especially the new elements added from MRV will be needed to improve quality of inventory results. This should include repeated measurements on identifiable trees (e.g. with numbered trees or additional documentation of tree position) to better identify and quantify bias between teams. • A special focus must be set on tree height measurements applying all relevant techniques (laser measurement tools as well as traditional distance and angle measurements). • SOPs should be followed to the end, including on-site check of protocols for completion and obvious errors. Introduction of electronic protocols on handheld devices could further improve data quality.

Deadwood

Outcome:	• Absence of deadwood did not allow analysis and inventory quality assessment.
Actions required:	• Include sites with standing and lying deadwood in future inventory training and test.

Litter

Outcome:	• Litter sampling showed partially high mean error and one recording error. Increase of sample will reduce mean error. • Proposal to close gap between litter pool (max diameter 2cm) and lying deadwood (min diameter 10cm) by increasing maximum diameter for litter to 10cm.
Actions required:	• Assess feasibility and impact of increasing maximum diameter for litter to 10 cm, with special focus on operational impact (cutting and collecting pieces up to 10 cm; lab processing of large pieces) and potential statistical effects (increase of variance due to less uniform distribution of larger pieces across sample site).

J.11 ADDITONAL TEST DOCUMENTS: TEST CASE DETAILS

The following tables describe the test cases and respective test steps and expected results. The latter are referenced in sections 9 to 14 of this test result report.

ID / Name	**2-01**	**Training and Documentation: Completeness and applicability**
Description	Review, training and feedback on field inventory documentation. Assessment of (training and documentation) gaps or improvement potential.	
Test type	1 – Documentation test	
Pre-requisites	• Field inventory documentation available (all pools to be measured, i.e. standing tree biomass) • Training completed	
Test Steps	4. Review SOP for completeness and applicability 5. Apply SOP in field training and testing (test case 2-02) 6. Collect feedback on documentation	
Expected Result (for each step)	1. SOP complete 2. Training based on SOP successful 3. Feedback collected	

ID / Name	**2-02**	**Field measurements: SOP efficiency and effectiveness, measurement techniques, data recording**
Description	Test all field measurement and sampling, including • setup of sample plot • measurement of standing trees (live trees, and standing deadwood) • measurement of lying dead wood • sampling of litter (field collection only) • ~~sampling of soil (field collection only)~~[42] This test case should be repeated with multiple teams across multiple sample plots.	
Test type	2 – Field testing	
Pre-requisites	• field teams trained • sample plots selected (multiple plots) • SOP / manuals and protocols for all pools, according to MRV design document (in language understandable to test participants)	
Test Steps	1. Go to sample plot coordinates and set up center and perimeter 2. Measure standing tree parameters according to SOP 3. Measure lying dead wood according to SOP 4. Collect litter sample according to manual ~~5. Collect soil sample according to manual~~	
Expected Result (for each step)	1. Sample site found and correctly marked 2. All tree parameters measured correctly 3. Transects installed correctly and lying dead wood measured 4. Litter sample collected correctly and ready for transport ~~5. Soil sample collected correctly and ready for transport~~	

[42] Soil sampling to be tested separately (out of scope for MRV inventory field tests).

ID / Name	**2-03**	**Data collection: database entry**
Description	Quality review and assessment of field protocols, followed by manual entry in database (or datasheet)	
Test type	2 – Field testing	
Pre-requisites	• Field protocols (from test case 2-02) • Inventory database (EMS "draft" database or flat file structure)	
Test Steps	1. Check field protocols for completeness and assess documentation quality 2. Enter all data from field inventory to database or datasheet (manual)	
Expected Result (for each step)	1. Field data complete 2. Field data entered in database (or datasheet)	

ID / Name	**3-01**	**Data quality: completeness, distribution, outliers and inconsistencies (raw data)**
Description	This test applies statistical methods and rule-based analysis to assess overall data quality and to identify erroneous data (outliers).	
Test type	3 – Data review	
Pre-requisites	• Inventory data in database or data sheet	
Test Steps	1. Check completeness of data 2. Check statistical distribution for bias and outliers 3. Check for erroneous/inconsistent data ("sanity check" for e.g. overly high trees or unreasonable height-to-DBH ratio)	
Expected Result (for each step)	1. Data entered 2. No bias or outliers 3. No inconsistent data	

ID / Name	3-02	Measurement accuracy: analysis of repeat measurements
Description	This test compares repeat analyses of a sample plot (i.e. from different team and runs) in order to assess measurement error or bias (and thus further training needs.)	
Test type	3 – Data review	
Pre-requisites	• Repeat measurements performed during inventory tests (test case 2-02) • Data entered in database or data sheet (test case 2-03)	
Test Steps	1. Test statistical significance of differences between measurement runs and teams	
Expected Result (for each step)	1. Statistical test completed - no significant differences	

ID / Name	3-03	Data applicability (system independent): sample model runs (OPTIONAL)
Description	This optional test is a proof-of-concept run of sample models (as available at time of testing), using the test inventory data.	
Test type	3 – Data review	
Pre-requisites	• Models (e.g. volume / biomass / carbon) implemented in test environment, e.g. EMS development environment or Excel sample. • Inventory data in database or data sheet • Additional data as needed for models	
Test Steps	1. Load data into test environment (inventory data plus additional data as needed for models) 2. Run model calculations 3. Assess model outputs	
Expected Result (for each step)	1. Data loaded 2. Model run successful (no errors) 3. Outputs consistent and within expectations	

J.12 ADDITONAL TEST DOCUMENTS: PICTURES FROM FIELD INVENTORY SAMPLE PLOTS

J.12.1 DAY 1

Figure J.12-1: Pictures of sample plot FD1 (taken from plot center)

North view | East view | South view | West view

Figure J.12-2: Pictures of sample plot FD2 (taken from plot center)

North view | East view | South view | West view

(no pictures available for FD3)

J.12.2 DAY 2

Figure J.12-3: Pictures of sample plot SD1 (taken from plot center)


North view


East view


South view


West view

Figure J.12-4: Pictures of sample plot SD2 (taken from plot center)


North view


East view


South view


West view

Figure J.12-5: Pictures of sample plot SD3 (taken from plot center)


North view


East view


South view


West view

SECTION K: APPENDIX

- Appendix A 2016 06 01 Turkey GDF SDG Matrix Draft V2.xlsx
- Appendix B TREES Field Inventory SOP Manual V001.pdf
- Appendix C VCS VMD0023 Estimation of Carbon Stocks in the Litter Pool, v1.0.pdf
- Appendix D VCS VMD0021 Estimation of Stocks in the Soil Carbon Pool v1.0.pdf
- Appendix E TREES MRV Forest Field Protocol Version 0_1.xlsx
- Appendix F TREES MRV Forest Field Protocol Version 0_1 Appendix.xlsx
- Appendix G Turkey Data and Model Questionnaire V2.docx
- Appendix H Turkey GDF SDG Questionnaire V3.docx
- Appendix I VMD0002 CP-D Dead wood Version_1.pdf
- Appendix J VMD0026 Estimation of Carbon Stocks in the Long Lived Wood Products Pool, v1.0.pdf
- Appendix K 2016 06 Turkey GDF SDG MRV Dashboard Template V2_1.xlsx