7 Estimating the baseline scenario and emissions

When using the emissions approach, estimating the GHG impacts of a policy requires a reference case, or baseline scenario, against which impacts are estimated. The baseline scenario represents what would have happened in the absence of the policy intervention. Baseline emissions and removals are estimated according to the most likely baseline scenario that includes credible assumptions on land use, land-use changes and timber management practices, and the associated emissions and removals that would have occurred without the implementation of the policy.

The method in this chapter can be used to determine the baseline scenario and estimate emissions ex-ante or ex-post. Estimating baseline emissions is optional; users can calculate the GHG impacts of the policy directly, without explicitly determining separate baseline and policy scenarios, using the activity data approach. In such cases, users can skip to *Chapter 8*.

Checklist of key recommendations

- Identify the intended policy outcomes and target drivers
- Stratify land by land-use category
- Estimate the area of land in each stratum
- Estimate the carbon stock change (i.e. emission factor) for each carbon pool in each land stratum
- Calculate the cumulative GHG emissions and removals for the baseline scenario over the assessment period

7.1 Determine the baseline scenario

The most likely baseline scenario is determined by drivers that affect GHG emissions and carbon stocks. This step requires identifying parameters for these drivers and making reasonable assumptions about their most likely values in the absence of the policy.

When determining the baseline scenario, consider how the sector would have developed without the policy. For example:

- What mitigation practices or technologies would be implemented in the absence of the policy?
- Are there existing or planned policies, other than the policy being assessed, that are likely to have an impact on GHG emissions for the forestry sector?
- Are there non-policy drivers (e.g. market trends or non-anthropogenic processes) or other sectoral trends that should be reflected in the baseline scenario? For example
  - » changes in the demand for harvested wood products
  - » improvements in timber and forest management practices
  - » land-use change (e.g. natural regeneration)
  - » trends in the agriculture sector
  - » trends in biofuel production
  - » trends in development (e.g. settlements and infrastructure).

FIGURE **7.1**

Overview of steps in the chapter

Determine the baseline scenario (Section 7.1) → Estimate baseline emissions (Section 7.2)

To the extent possible, users should identify a single baseline scenario that is considered to be the most likely. In certain cases, multiple baseline options may seem equally plausible. Users can develop multiple baselines, each based on different sets of assumptions, rather than just one set. This approach produces a range of possible emissions reduction scenarios. Users can then conduct a sensitivity analysis to see how the results vary depending on the selected baseline scenario. More guidance about conducting a sensitivity analysis is provided in Chapter 12 of the *Policy and Action Standard*.

Users who are assessing the sustainable development, transformational or other GHG impacts of the policy should use the same underlying assumptions about macroeconomic conditions, demographics and other non-policy drivers. For example, if gross domestic product (GDP) is a macroeconomic condition needed for assessing both the job impacts and economic development impacts of an agriculture policy, users should use the same assumed value for GDP over time for both assessments.

7.1.1 Approaches to determining the baseline scenario

This section describes approaches to determining the most likely baseline scenario. There are multiple ways to project the baseline scenario, ranging from simple to complex. Depending on the availability and quality of forecasting data, any of the following approaches can be used for determining the baseline scenario. Figure 7.2 illustrates the different approaches.

Constant baseline
The constant baseline approach assumes that there will be no change in land use, land cover or forest management practices during the baseline period. It is the simplest approach because only historical data are required. Either the most recent available data or an average of the data from at least three years before the start of the policy implementation can be used to quantify the baseline parameters. This approach then assumes that the parameters are held constant for the assessment period, and the baseline is the continuation of the current or historical situation. For example, land will remain degraded under the baseline scenario. Although this baseline approach is the easiest, assessments based on a constant baseline may be less accurate.

Simple trend baseline
The simple trend baseline approach assumes that land use, land cover and forest management practices will evolve in the same way as in the past. This approach typically uses a linear or exponential extrapolation of the historical trend for each baseline parameter. Users can employ a statistical regression analysis to estimate trends. This approach can be easy to implement, but it does not include any assumptions about future policy measures or future mitigation actions. This approach should use historical data from 5–10 years before the implementation of the policy. More data points will strengthen the regression analysis. For example, land-use change in the future can be estimated by assuming that the same rate of change before policy implementation continues in the baseline.

Advanced trend baseline
The advanced trend baseline approach models the future evolution of the key drivers of emissions and factors, taking into account many interacting elements, including trends in macroeconomic conditions, demographics and other non-policy drivers.

A modelled baseline can be top-down or bottom-up:

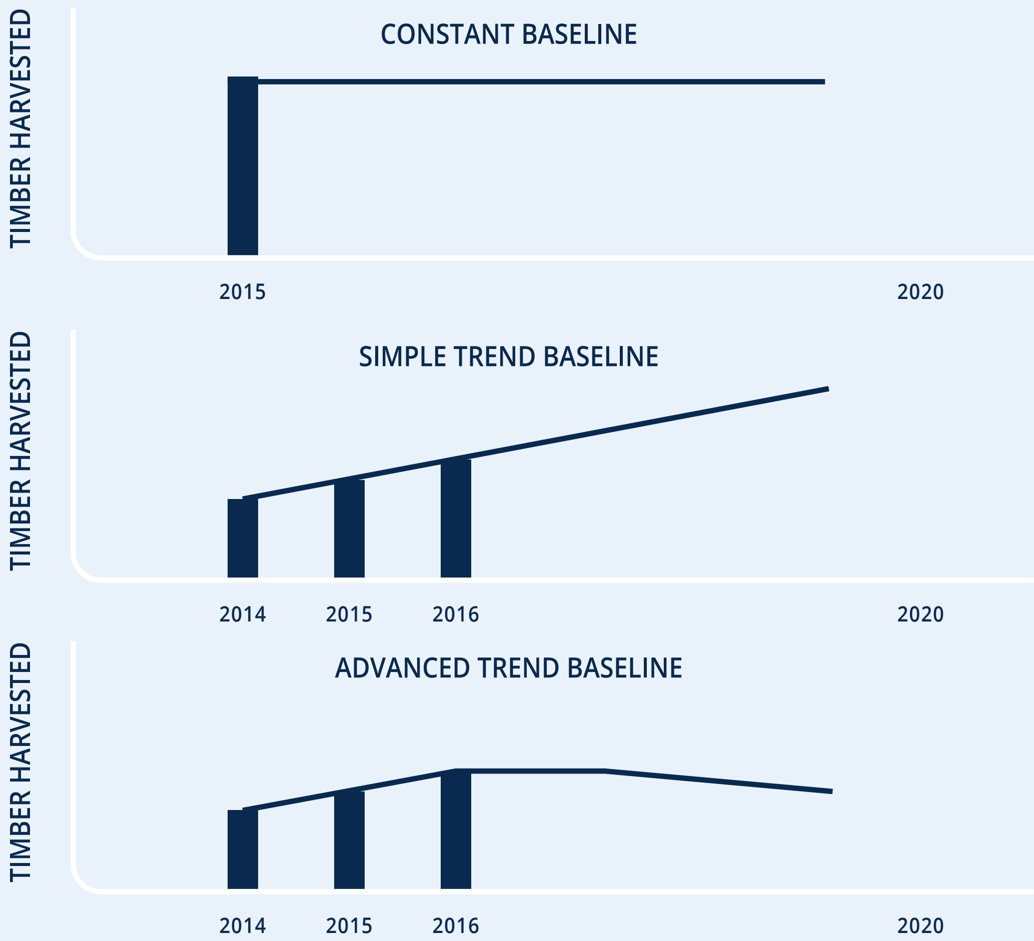
- **Top-down model.** This models how the economy or other exogenous factors (e.g. macroeconomic and demographic conditions) will impact the forestry sector. For example, the approach may model how population growth will impact land use, and then uses population forecasts to predict baseline land-use change.

- **Bottom-up model.** This approach models the interaction of key drivers on specific land use, land-use change and forest management practices. It can offer a more detailed projection of specific GHG sources and carbon pools. This approach is likely to require detailed data, such as forest inventory data, and data on drivers of land-use change, or specific timber or forest management practices. It is suitable in countries where emissions from this sector are small or their economic output is modest, because the expected trends in macroeconomic and demographic conditions may not be a good indicator of land use or land-use change.

A land use, land-use change and forestry (LULUCF) model projects the land use and land-use changes that are expected to occur in the baseline. A

FIGURE **7.2**

Examples of constant, simple trend and advanced trend baselines



comprehensive LULUCF model covers the following dimensions:

- **Sectoral.** There is sufficient detail to identify targeted economic opportunities within and across the sectors (e.g. land-use change, forest management, agricultural management, biofuel production). The model could include a market-clearing price and resource competition to capture the impact of mitigating emissions where forest and agriculture products are affected.

- **Spatial.** The model accounts for the heterogeneity of biophysical and economic conditions within and across regions as they relate to the production of food, fibre and fuel. For example, carbon sequestration rates can vary regionally. A spatial model could also model competition for region-specific resources, such as land and water, which affects economic responsiveness in forestry and agriculture.

- **Temporal.** The model can capture dynamic biophysical processes (e.g. soil and biomass carbon accumulation, fate of harvested wood products). It could also capture dynamic economic processes (e.g. investment, technological progress, demand trends, traditional commodity developments).

LULUCF models can be categorized according to their functional and methodological aspects, as follows:

- statistical or econometric models
- spatial interaction models
- optimization models (which include linear, dynamic, hierarchical and non-linear programmes, such as utility maximization models and multi-criteria decision-making models)
- integrated models (gravity, simulation and entry–exit models)
- models based on natural sciences
- models based on GIS
- models based on the Markov chain.[14]

A number of existing models can be used to project an advanced trend baseline. For example, the Global Biosphere Management Model (GLOBIOM) is an economic partial equilibrium model of the competition for global land use. In GLOBIOM, the demand for land is modelled based on exogenously specified regional drivers (including GDP growth, population growth, evolution of food diets and global bioenergy demand), and local characteristics of the land. Brazil has considered a model that includes the dynamics of land use that will be affected by competition and scale. The model provides the results of land allocation to different regions and biomasses in the country, thereby projecting the type of natural vegetation that is converted (deforested) into agricultural land. The projections are based on country-level plans up to 2030.[15]

7.1.2 Data sources

Multiple types of data can be used to develop baseline scenarios, including top-down and bottom-up:

- **Top-down data** – macro-level data or statistics collected at the jurisdictional or sectoral level. Examples are economic data on milk or meat consumption, land-use maps, population and GDP. In some cases, top-down data are aggregated from bottom-up data sources.
- **Bottom-up data** – data that are measured, monitored or collected at the facility, entity or project level. Examples are agricultural or livestock census data on current and/or historical livestock population, species and feed intake; and land-use categories classified by climate region, soil type and management.

The key parameters for estimating baseline emissions and removals in forests are:

- **activity data** – hectares of forest land remaining forest land, non-forest land converted to forest land, and forest land converted to non-forest land
- **carbon stock change factor** – the net change in carbon stocks per hectare of land, which can also be expressed as CO_2 emissions and removals per hectare of land. The carbon stock change represents the emission factor for a land use or land management.

Existing data that have been collected for other assessments (including from national GHG inventories, national communications, biennial update reports and biennial transparency reports[16]), which are prepared following IPCC guidelines, can be used for determining the baseline scenario, and estimating baseline emissions and removals. Where relevant, it may be important to use data that are consistent with national- or subnational-level sectoral baselines. Sources of data for the key parameters include:

- forest cover maps and regionally specific data
- country-level data from NAMA and low-carbon development programmes
- country-level REDD+ reporting or studies (e.g. national or subnational REDD+ forest reference emissions levels [FRELs] or forest reference levels [FRLs])
- Global Forest Watch data,[17] United States Geological Survey datasets,[18] or databases of the Food and Agriculture Organization of the United Nations.[19]

[14] MAPA (2015).

[15] MAPA (2015)

[16] Biennial transparency reports will supersede the biennial update report requirements from December 2024.

[17] Available at: www.globalforestwatch.org.

[18] Available at: https://archive.usgs.gov/archive/sites/landcover.usgs.gov/globallandcover.html.

[19] Available at: www.fao.org/faostat/es.

7.1.3 Choosing the approach to determine the baseline scenario

The choice of approach to determine the baseline scenario depends on users' resources, capacity, access to data, and availability of models and methodologies, and the parameters that are expected to change. A constant baseline is the simplest option and may be appropriate when parameters are considered likely to remain stable over time. A simple trend baseline is most appropriate if the change in baseline parameter values is expected to remain stable over time. Advanced trend baseline approaches may yield more accurate results than other approaches, since they take into account various drivers that affect conditions over time. However, more complex baselines will only be more accurate if the underlying data and methods used to model the impacts of drivers are robust. Users should use methods and data that yield the most accurate results within a given context, based on the resources and data available.

7.2 Estimate baseline emissions

This section provides a method for estimating baseline emissions. It provides suggestions for identifying data sources and methods for projecting key baseline scenario parameters. Figure 7.3 outlines the steps in this section.

The method can also be used to estimate policy scenario emissions for forest policies. To estimate policy scenario emissions, the same method should be used that was used to estimate baseline emissions, with new parameter values derived following the method in Sections 8.2–8.5 and, if relevant, new emission factors that represent conditions under the policy scenario. The policy scenario can be estimated ex-ante or ex-post using these methods.

Changes in land use can lead to an increase or decrease in forest carbon. For example, conversion of cropland to forest land results in a net increase in forest carbon. Conversely, conversion of cropland to forest land (deforestation) results in net losses of forest carbon. Where land use remains the same over time (e.g. forest land remaining forest land), changes in management (e.g. increasing the minimum age of tree cutting thresholds) can result in net increases or decreases in forest carbon. Policy impacts on forest carbon are estimated in terms of how the policy changes land use and management.

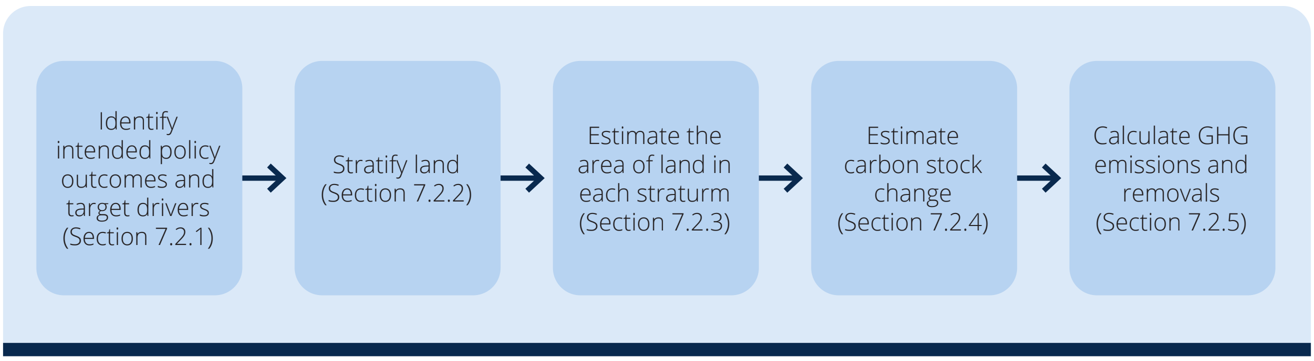
7.2.1 Identify intended policy outcomes and target drivers

It is a *key recommendation* to identify the intended policy outcomes and target drivers. There are generally four types of policy outcomes in the forestry sector:

- Increase forest carbon stocks by converting land to forests (A/R).
- Increase forest carbon stocks in existing forests.
- Reduce emissions from deforestation.
- Reduce emissions from degradation.

FIGURE **7.3**

Steps for estimating baseline emissions



Drivers are a categorical description of agents and processes that lead to GHG emissions in the forestry sector in the baseline scenario. Policies enable or incentivize measures that are designed to affect target drivers. Table 7.1 provides examples of target drivers as they relate to intended policy outcomes. The target drivers need to be identified in the baseline scenario because assumptions about them are modified to develop the policy scenario.

Drivers that are not affected by the policy do not need to be analysed, because they are assumed to remain constant between the baseline and policy scenarios. For example, if the policy focuses on afforestation on degraded lands, it can be assumed that logging practices on lands managed for timber will remain the same.

The data for key parameters will vary depending on the intended policy outcome. Table 7.2 provides general descriptions of the key parameters associated with each type of policy outcome.

7.2.2 Stratify land

It is a *key recommendation* to stratify land by land-use category. Following the method in Section 6.1.1, step 3, users should identify the affected land categories where changes in land use and forest management are expected to occur under the policy scenario. At a high level, the possible affected land categories are:

- forest land converted to non-forest land
- forest land remaining forest land
- non-forest land converted to forest land.

For each of the land categories in the GHG assessment boundary, users should further divide them into subcategories by climate information, forest types and forest management. Where available, country-level stratification of forest type and biomass values from the country's national GHG inventory should be used.

TABLE **7.1**

Example relationships between intended policy outcomes, target drives and policy measures

Intended policy outcome	Example drivers and barriers	Example policy measures
Enhance forest carbon stocks by converting land to forests	Barriers to natural regeneration	Plant trees Remove barriers to natural regeneration Make sites suitable for natural regeneration
Enhance forest carbon stocks with existing forests	Poor forest management	Encourage implementation of sustainable forest management Reduce the size of logging roads Reduce damage of other trees when logging
Reduce emissions from deforestation	Illegal logging Economic pressure for more agricultural production that requires agricultural land expansion	Introduce and improve systems to effectively enforce existing or new regulation for forest protection Intensify agriculture
Reduce emissions from degradation	Unsustainable biomass removals from selective logging and fuelwood gathering Overfrequent burning	Introduce and improve systems to effectively enforce existing or new regulation of fuelwood collection

TABLE **7.2**

Key parameters by policy outcome

Intended policy outcome	Activity data	Carbon stock change
Increase forest carbon stocks within existing forests	Area of forest land remaining forest land where management can be improved	CO_2 removals per hectare from enhancements
Increase forest carbon stocks by converting land to forests	Area of land converted to forest land	CO_2 removals per hectare from biomass and soil, from land conversion
Reduce emissions from deforestation	Area of forest land converted to non-forest land	CO_2 emissions per hectare from deforestation
Reduce emissions from degradation	Area of forest land remaining forest land where degradation occurs	CO_2 emissions per hectare from degradation

The IPCC 2006 GL provides a land categorization for forests that is compatible with Tier 1 estimation methods. To use the IPCC categorization, users should identify the ecological zones and forest management types that correspond to the forest land in that category. Ecological zones are areas with relatively homogeneous vegetation. The IPCC defines ecological zones based on climate domain and climate region, where climate domain is an area of relatively homogeneous temperature, and climate region is an area with a relatively similar climate in terms of both moisture and temperature. Examples of ecological zones are tropical rainforest, subtropical humid forest, temperate oceanic forest and boreal coniferous forest. IPCC definitions of ecological zones according to climate domain and climate region are provided in Table 4.1 of the IPCC 2006 GL, volume 4, Chapter 4.

Within each ecological zone, users should further define subcategories of forest land in terms of how the forests are managed. The IPCC provides two categories for this: natural and plantation forest. Natural forests are generally naturally regrowing stands with reduced or minimum human intervention. Plantation forests are intensively managed (including planted, managed, harvested and replanted). The IPCC provides Tier 1 estimated biomass values for natural and plantation forests for all ecological zones (Table 4.12 of the IPCC 2006 GL, volume 4, Chapter 4). The IPCC biomass values and information about forest management and forest biomass in the user's country should be used to develop criteria for classifying forests into natural and plantation. The criteria used need to be documented.

The subcategories outlined above (i.e. ecological zone and management type) are recommended because they are compatible with using IPCC Tier 1 emission factors for estimating the carbon in forest biomass. The land categorization can be done differently where Tier 2 emission factors are available or a derived Tier 2 estimate of CO_2 emissions and removals for each land category can be calculated. Where the policy aims to reduce forest degradation, higher approaches and tiers should be used to capture changes. Such methods require more data, but can yield a more accurate GHG impact assessment. Users should consider the objectives of the policy when selecting which method to use.

7.2.3 Estimate the area of land in each stratum

It is a *key recommendation* to estimate the area of land in each stratum. Land area can be derived from national data sources that are widely accepted among policymakers and endorsed by the government. Potential data sources include remotely sensed and aerial imagery, ministry of agriculture or forests, national agricultural or forest research institutes, and international agencies (e.g. Food and Agriculture Organization of the United Nations). Data on land area compiled for the national GHG inventory are also a relevant data source. These data sources will typically provide information on historical and current land area.

Several resources detail how to develop land area estimates for forest carbon monitoring:

- IPCC 2003 *Good Practice Guidelines for Land Use, Land-Use Change and Forestry*[20]
- IPCC 2006 GL, volume 4, *Agriculture, Forestry and Other Land Use*[21]
- *Global Observation of Forest Cover and Land Dynamics (GOFC GOLD) Sourcebook*[22]
- Winrock *Standard Operating Procedures for Terrestrial Carbon Measurement*, 2014[23]
- Global Forest Observation Initiative methods and guidance documentation.[24]

These resources can be used to estimate a time series of land area for the baseline assessment. The time series is the number of hectares of land in each land stratum each year of the assessment period. Any of the approaches discussed in Section 7.1 can be used to project the hectares of land over time based on current and historical data.

7.2.4 Estimate carbon stock change

It is a *key recommendation* to estimate the carbon stock change (i.e. emission factor) for each carbon pool in each land stratum. At a minimum, the carbon stock change for the living above-ground and below-ground biomass (living biomass) pool should be estimated. For A/R and reduced deforestation activities, carbon stock change for dead organic matter and soil carbon pools can also be estimated, where these pools are included in the GHG assessment boundary.

When deciding which pools to estimate the carbon stock change for, users may encounter trade-offs between the principle of accuracy and the cost of collecting data. Conservativeness can moderate accuracy, to balance costs while maintaining the credibility of the GHG estimate. Users can rely on existing data and methods for estimating carbon stock change, including:

- national forest inventories
- subnational or regional forest inventory data sets
- relevant independent or regional scientific studies or data sets
- values published in scientific literature
- values provided in the IPCC 2006 GL.

The method below is for estimating carbon stock change based on the living biomass carbon pool only.

Land-use change

For A/R or reduced deforestation where land use changes (e.g. non-forest land converted to forest land and vice versa), the carbon stock change is the average change in forest carbon stocks per unit area as a result of land being afforested/reforested or deforested. In general, this can be estimated as the difference between the forest carbon stocks per unit area before and after the land conversion, as shown in equation 7.1 (based on equation 2.16 in the IPCC 2006 GL). Equation 7.1 includes the area term representing activity data. Executing the equation with the area term yields total emissions and removals in terms of tonnes of carbon per year for all land conversions. Executing the equation without the area term will yield a per area carbon stock change for each type of land conversion.

As noted above, Tier 1 estimated biomass values for natural and plantation forests for all ecological zones are provided in Table 4.12 of the IPCC 2006 GL, volume 4, Chapter 4. These values can be used to develop Tier 1 carbon stock change factors for A/R and reduced deforestation, using the equation above. Values for biomass stocks in the non-forest land pre- or post-conversion categories can be found in Table 5.9 (croplands) or Table 6.4 (grasslands) of the IPCC 2006 GL.

For a rough estimate of a deforestation carbon stock change, use zero for the value of $B_{\text{after},i}$. This will overestimate emissions from deforestation because the biomass gains that occur in the post-conversion land category are not counted (i.e. the loss in biomass as a result of conversion is overestimated). However, this is likely to be a proportionally small overestimation because post-conversion biomass

[20] Available at: www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html.

[21] Available at: www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html.

[22] Available at: www.gofcgold.wur.nl/redd.

[23] Available at: www.leafasia.org/tools/winrock-standard-operating-procedures-terrestrial-carbon-measurementfield-sop-manual.

[24] Available at: www.fao.org/gfoi.

Equation 7.1: Carbon stock change from land conversion

$$\Delta C_{\text{conversion}} = \sum_{i} \{(B_{\text{after},i} - B_{\text{before},i}) \times A_{To\_NF,i}\} \times CF$$

where

$\Delta C_{\text{conversion}}$ = carbon stock change on land type *i* (tonnes of carbon per year)

$B_{\text{after},i}$ = biomass stocks[25] on land type *i* after the conversion (tonnes of dry matter per hectare)

$B_{\text{before},i}$ = biomass stocks[23] on land type *i* before the conversion (tonnes of dry matter per hectare)

$A_{To\_NF,i}$ = area of land use *i* converted to non-forest land (*NF*) in a certain year (hectares per year)

CF = carbon fraction of dry matter (tonnes of carbon per tonne of dry matter)

i = type of land converted to non-forest land

stocks are relatively small compared with pre-conversion forest carbon stocks.

For a rough estimate of an A/R carbon stock change, use zero for the value of $B_{\text{before},i}$. This will overestimate removals from A/R because it does not count the biomass stocks that existed before conversion (i.e. the gain in biomass as a result of conversion is overestimated). This is also likely to be a proportionally small overestimation because pre-conversion biomass stocks are relatively small compared with post-conversion forest carbon stocks.

[25] Note: Biomass stocks × *CF* = carbon stocks. The carbon fraction converts units of dry matter (a common measure in forestry) to units of carbon with a basic conversion factor that varies by climate region. The IPCC 2006 GL provides default carbon fraction values in Table 4.3.

Forest land remaining forest land

For forest land remaining forest land, the carbon stock change is the average annual change in forest carbon stocks per unit area. This can be estimated in one of two ways according to the IPCC 2006 GL:

- **Stock-difference method.** The average annual change in forest carbon stocks is calculated as the difference in average forest carbon stocks between two points in time, divided by the time period, as shown in equations 7.2a and 7.2b (adapted from the first part of equation 2.8 in the IPCC 2006 GL). The stock-difference method is most suitable when the availability of information and/or resources is good (e.g. Tier 2, approach 2 or 3) – for example, national forest inventories or data sets that allow estimates of carbon stocks by forest type, specific to local or regional conditions, over time. In most cases, it is not appropriate to use a Tier 1 method for a stock-difference calculation.[26]

- **Gain–loss method.** The average annual change in forest carbon stocks is calculated as a process of gains and losses. Gains result from annual forest growth, and losses result from processes such as wood harvesting, fuelwood extraction and disturbance, as shown in equation 7.3. The gain–loss method is most suitable when countries do not have time series information on activity data and emission factors to assess using the stock-difference method.

Both the stock-difference and gain–loss methods are executed with the area term (activity data) in the equations, which yields total change in carbon stocks for all land strata in forest land remaining forest land.

Therefore, the carbon stock change is embedded in the quantification of total emissions and removals.

[26] See IPCC GL, Section 2.3.1.1. Available at: www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf.

Stock-difference method

Equation 7.2a: Part 1 of stock-difference method for estimating carbon stock change

$$\Delta C = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$

where

ΔC = annual forest carbon stock change (tonnes per year)

C_{t_1} = forest carbon stock at time t_1 (tonnes of carbon)

C_{t_2} = forest carbon stock at time t_2 (tonnes of carbon)

The terms C_{t_1} and C_{t_2} can be estimated with equation 7.2b (adapted from the second part of equation 2.8 in the IPCC 2006 GL). Like equation 7.1, equation 7.2b includes the area term representing activity data. Executing equation 7.2b without the area term will yield a per area carbon stock value for a given land stratum defined by ecological zone and climate domain.

Equation 7.2b: Part 2 of stock-difference method for estimating carbon stock change

$$C = \sum_{ij} \{A_{i,j} \times V_{i,j} \times BCEF_{S i,j} \times (1 + R_{i,j}) \times CF_{i,j}\}$$

where

C = total carbon stock in living biomass in all forest land remaining forest land at a given point in time

$A_{i,j}$ = area of forest land remaining forest land (hectares), in ecological zone *i* and climate domain *j*

$V_{i,j}$ = merchantable growing stock volume (cubic metres per hectare) for forests in ecological zone *i* and climate domain *j*

$BCEF_{S i,j}$ = biomass conversion and expansion factor for expansion of merchantable growing stock volume to above-ground biomass (tonnes of above-ground biomass growth per cubic metre of growing stock volume), for forests in ecological zone *i* and climate domain *j*

$R_{i,j}$ = ratio of below-ground to above-ground biomass (tonnes of dry matter below-ground biomass per tonne of dry matter above-ground biomass), for forests in ecological zone *i* and climate domain *j*

$CF_{i,j}$ = carbon fraction of dry matter (tonnes of carbon per tonne of dry matter)

Gain–loss method

Equation 7.3: Gain–loss method for estimating carbon stock change

$$\Delta C_B = \sum_{ij} [G_{W_{i,j}} \times (1 + R_{i,j}) \times A_{i,j} \times CF_{i,j}] + L_{\text{wood-removals}} + L_{\text{fuelwood}} + L_{\text{disturbance}}$$

where

ΔC_B = annual net change in carbon stocks in living biomass in all forest land remaining forest land (tonnes of carbon per year)

i = ecological zone (i = 1 to n)

j = climate domain (j = 1 to m)

$G_{W_{i,j}}$ = average annual above-ground biomass growth rate for a specific forest type (tonnes of dry matter per hectare per year)

$R_{i,j}$ = ratio of below-ground biomass to above-ground biomass of the specific forest type; for Tier 1, $R_{i,j}$ can be set to zero

$A_{i,j}$ = area of forest (hectares)

$CF_{i,j}$ = carbon fraction of dry matter (tonnes of carbon per tonne of dry matter)

$L_{\text{wood-removals}}$ = annual above-ground biomass carbon loss due to wood removals (tonnes of carbon per year)

L_{fuelwood} = annual above-ground biomass carbon loss due to fuelwood removals (tonnes of carbon per year)

$L_{\text{disturbance}}$ = annual above-ground biomass carbon losses due to disturbances (tonnes of carbon per year)

Guidance and equations for estimating $L_{\text{wood-removals}}$, L_{fuelwood} and $L_{\text{disturbance}}$ are provided in the IPCC 2006 GL, volume 4, Chapter 4.

With the gain–loss method, there are two options for estimating $G_{W_{i,j}}$ (average annual above-ground biomass growth rate):

- **IPCC default values.** Default values for net biomass growth are available in Table 4.12 of the IPCC 2006 GL, volume 4, Chapter 4.
- **Mean annual growth.** Mean annual growth is also called mean annual increment (MAI). MAI describes the typical growth rates of trees in forests of a given type and age class. It is a fairly common measure collected by forestry agencies or forest managers. Consult the IPCC 2006 GL for further information on how to use MAI to estimate $G_{W_{i,j}}$.[27]

Further resources
Comprehensive guidance on estimating forest carbon stock changes in all carbon pools can be found in numerous resources:

- IPCC 2003 *Good Practice Guidelines for Land Use, Land-Use Change and Forestry*
- IPCC 2006 GL, volume 4, *Agriculture, Forestry and Other Land Use*
- Global Observation of Forest Cover and Land Dynamics (GOFC–GOLD) sourcebook

[27] See IPCC 2006 GL, Section 2.3.1.1, Subsection A.1. Available at: www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_02_Ch2_Generic.pdf.

- Winrock *Standard Operating Procedures for Terrestrial Carbon Measurement* 2014
- Global Forest Observation Initiative (GFOI) methods and guidance documentation.

The GOFC–GOLD sourcebook, and GFOI methods and guidance documentation are particularly relevant resources for estimating carbon stock change for multiple carbon pools for enhancing carbon stocks through A/R, enhancing carbon stocks through management, deforestation, and degradation. Where higher-tier data are available (including emission factors, biomass values or land stratification), such data can be used to increase accuracy and completeness of the estimate.

7.2.5 Calculate GHG emissions and removals

It is a *key recommendation* to calculate the cumulative GHG emissions and removals for the baseline scenario over the assessment period. Estimate annual carbon stock change for each land stratum each year in the baseline scenario using area data and carbon stock change equations provided above for land-use change (A/R and reduced deforestation) and forest land remaining forest land. Sum annual carbon stock changes by stratum across all land strata to yield net annual carbon stock change on lands in the GHG assessment boundary.

Finally, sum the annual carbon stock changes for all years in the assessment period to yield cumulative carbon stock change in the baseline scenario. Convert the cumulative carbon stock change to GHG emissions (expressed as tonnes of carbon dioxide equivalent [CO_2e]) by multiplying the cumulative carbon stock change by 44/12 and by –1. This yields total cumulative CO_2e emissions (positive) or removals (negative) for the baseline.

8 Estimating GHG impacts of the policy ex-ante

This chapter describes how to estimate the expected future GHG impacts of the policy (ex-ante assessment). Users estimate the maximum implementation potential of the policy based on the causal chain that was developed in Chapter 6. Users then evaluate how barriers to implementation and other factors may limit the policy's overall effectiveness, and determine the likely implementation potential of the policy. The likely implementation potential represents the effects that are expected to occur as a result of the policy (most likely policy scenario). Implicitly, these effects are relative to the baseline scenario.

There are two ways that users can estimate the GHG impacts of the policy scenario based on the implementation potential of the policy. Using the emissions approach, the GHG impacts are estimated by subtracting the baseline emissions (as determined in Chapter 7) from policy scenario emissions (as determined in this chapter). Alternatively, users can estimate the relative change in GHG emissions based on the likely implementation potential of the policy, using the activity data approach.

Checklist of key recommendations

- Determine the maximum implementation potential of the policy
- Analyse policy design characteristics and national circumstances that may reduce the effectiveness of the policy, and account for their effect on the maximum implementation potential
- Analyse the financial feasibility of the policy for each stakeholder group and account for the effect on the implementation potential of the policy
- Analyse other barriers that could reduce the effectiveness of the policy and account for their effect on the implementation potential of the policy
- Estimate the GHG impacts of the policy

8.1 Introduction to estimating the implementation potential

The policy scenario represents the events or conditions that are most likely to occur in the presence of the policy being assessed. The method focuses first on estimating the "maximum implementation potential" of the policy. The maximum implementation potential of the policy assumes that all inputs, activities and intermediate effects in the causal chain are highly likely to occur

FIGURE **8.1**

Overview of steps in the chapter

Determine the maximum implementation potential of the policy (Section 8.2) → Refine the maximum implementation potential to the likely implementation potential (Sections 8.3 to 8.5) → Estimate the GHG impacts of the policy (Section 8.6) as planned and at the implementation level intended by the policy. It represents the intended policy outcome or policy effectiveness. The maximum implementation potential is then refined to the likely implementation potential (e.g. most plausible policy scenario) by taking into account factors that could reduce the effectiveness of the policy.

Subsequent sections of this chapter provide methods for estimating the implementation potential of the policy based on policy design characteristics and national circumstances (Section 8.3), financial feasibility (Section 8.4) and other barriers (Section 8.5). Figure 8.2 outlines the steps in this process. Most of the analysis in Sections 8.2–8.5 will be qualitative and require expert judgment, expert elicitation and/or stakeholder input. Guidance on expert judgment is provided in Section 4.2.4.

Figure 8.3 illustrates how the maximum implementation potential of the policy is refined at each step to achieve a more realistic estimate of the implementation potential. When determining the likelihood and magnitude of each refinement step, implicitly, any additional assumptions should be applied to the implementation potential quantified in the previous refinement step, so that the total reduction from maximum implementation potential to likely implementation potential is calculated in an accurate and stepwise manner. It is possible that the policy's likely implementation potential could exceed the estimated maximum implementation potential. This could occur where policies have a reinforcing effect (as discussed in Section 5.2.1).

These steps focus on estimating the implementation potential of the policy in terms of activity data rather

FIGURE **8.2**

Overview of steps for estimating the likely implementation potential of the policy

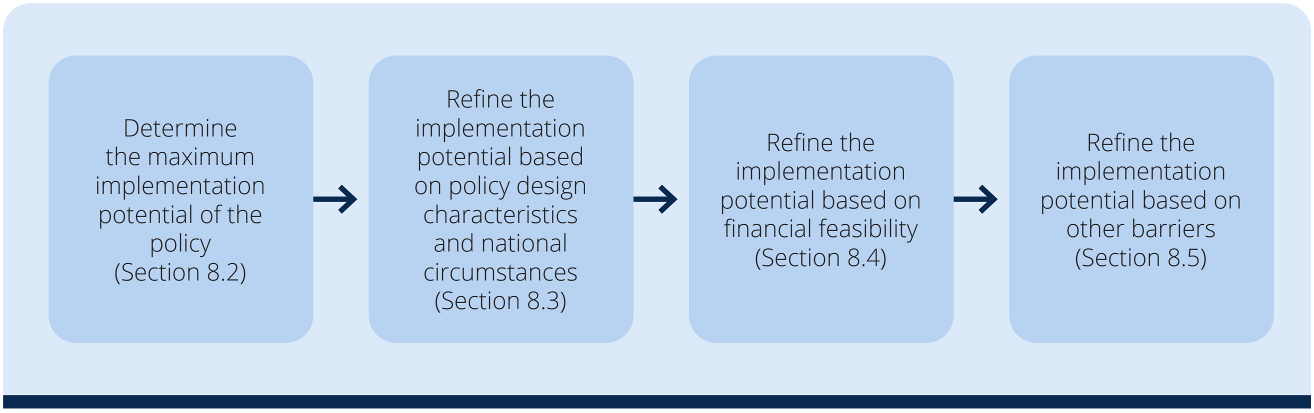
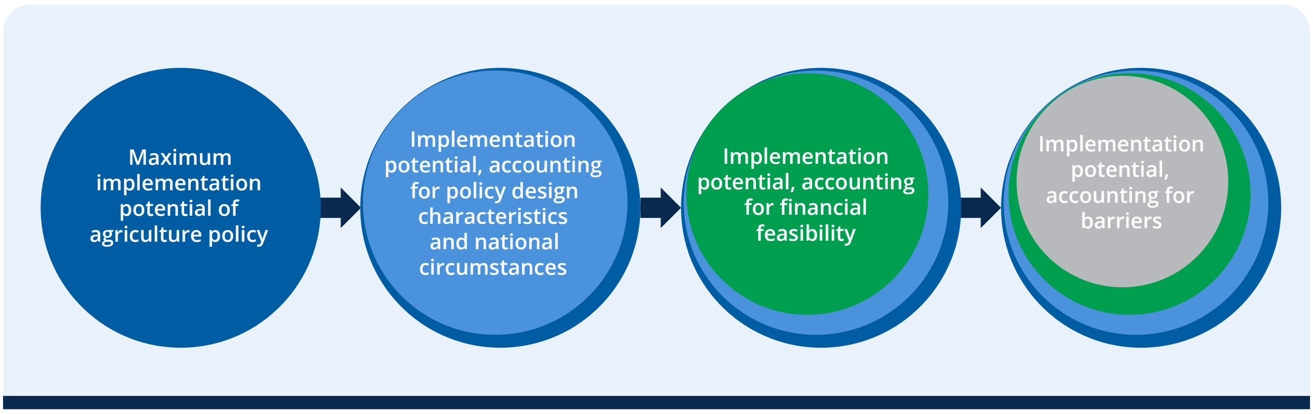


FIGURE **8.3**

Refining the maximum implementation potential to the implementation potential



than GHG emissions. Examples of such activity data are discussed in Section 8.2. The GHG impacts for each GHG source or carbon pool in the GHG assessment boundary will be determined using the final refined estimates of the activity data after completion of the four steps, following the method in Section 8.6.

Where quantitative information about how a factor is likely to impact the implementation potential of the policy is available, it can be used to estimate the effect of the policy. For example, an analysis may indicate that a barrier reduces the effectiveness of the policy intervention by 5%. Reduction in effectiveness can apply at two different levels:

- **General level.** The barrier affects the entire policy (e.g. a barrier that hinders deployment across all components of the policy). In this case, the 5% reduction applies to the overall policy effect.

- **Component level.** The barrier affects only one specific aspect of the policy (e.g. a barrier that hinders policy implementation for only a segment of the total population, one of the land-use categories considered, some regions of the country or the adoption rate of one agricultural practice). In this case, the 5% reduction applies only to the specific aspect of the policy affected by the barrier.

To the extent possible, users should identify a single policy scenario that is considered to be the most likely. In certain cases, multiple policy scenario options may seem equally plausible. Users can develop multiple policy scenarios, each based on different sets of assumptions, rather than just one set. This approach produces a range of possible emissions reduction scenarios. Users can then conduct a sensitivity analysis to see how the results vary depending on the selection of policy scenario options. More guidance about conducting a sensitivity analysis is provided in Chapter 12 of the *Policy and Action Standard*.

Box 8.1 gives an example of how to estimate the implementation potential of a policy. The implementation potential of the example policy is assessed on the basis of the estimated number of hectares of land on which the policy will be implemented.

8.2 Determine the maximum implementation potential

It is a *key recommendation* to determine the maximum implementation potential of the policy. For each GHG source or carbon pool in the GHG assessment boundary, users should choose a type of activity data to assess the implementation potential of the policy. The type of activity data chosen should be a parameter that is expected to change as a result of the policy (e.g. hectares of forest land prevented from being converted to cropland) and can be used to estimate GHG impacts. That is, the activity data serve as a proxy for the policy outcome. The maximum implementation potential is expressed in terms of activity data. Table 8.1 provides examples of types of activity data to consider.

BOX **8.1**

Example of forest policy for national- or subnational-level GHG mitigation

The government is considering the option of promoting SFM and A/R through the introduction of a payment for ecosystem services (PES) programme, combined with a new tax legislated for users of ecosystem services. Government officials are in the initial phase of the policy development process, and need to consider all aspects relating to legislating, designing and implementing the policy intervention. It is expected that the national legislative body will enact a new tax for all users of ecosystem services (primarily for water and hydroelectric utilities, but other sectors may be included, such as tourism companies). The national taxing agency will collect the tax, which will fund a new PES programme (estimated to be about 1–2% of annual revenue) to provide programme incentives, as well as administrative and operational expenses.

The goals for the PES programme are to (1) expand SFM activities and (2) promote A/R through tree planting or natural regeneration.

Further details on the policy can be found in Section 5.1.

TABLE **8.1**

Examples of types of activity data for analysing implementation potential of a policy

GHG source or carbon pool	Policy	Activity data
Biomass and soil carbon	• Incentives for SFM • Payments for A/R • Technical assistance to improve management • Introduction and improvement of systems to effectively enforce existing or new environmental regulation	• Hectares of forest land prevented from being converted to non-forest land • Hectares of forest land remaining forest land where management is improved • Hectares of forest land remaining forest land where sustainable forest management is implemented • Hectares of cropland converted to forest land • Hectares of grassland converted to forest land

The maximum implementation potential can be estimated based on a number of elements. The options include using a mitigation goal, expected adoption of practices or technologies, financial considerations, land area and other resource potential, and expert judgment. Each element is explained below. The maximum implementation potential is the theoretical intent of the policy effect without "friction" created by barriers that limit the policy's efficacy. The maximum implementation potential can be estimated using a single element or a combination of elements. A combination is likely to yield a better estimate.

8.2.1 Mitigation goal

When there is an intended level of mitigation and/or an explicit goal for the policy, the goal and other details of the policy can be used to estimate the maximum implementation potential. A mitigation goal may include, among other things, the target amount of emissions reductions or enhancement of carbon stocks as a result of the policy, the targeted amount of land area or adoption rate, or the total expected emissions reductions and removals from a specific GHG source or carbon pool. The mitigation goal may be in different units from the activity data, and additional information from surveys and national statistics may be needed to estimate how the goal will translate into actions or land areas. For example, an explicit goal for a forest policy could be to increase the minimum diameter cutting threshold on all publicly managed timber forests by 2020.

Where the results of the assessment will be used to meet the reporting requirements of the transparency framework, users should consider aligning the parameters used for the emissions projections of forest policies with those used to develop sectoral projections. It is recommended to align the time frame used for the emissions projections of forest policies with the time frame used for sectoral projections developed to meet the reporting requirements of the transparency framework (e.g. the starting and final year of the assessment period developed for a forest policy should be the same as the starting and final year of the forest sector projections).

Using a stated goal as the main indication of intended policy outcomes or policy effectiveness can be highly uncertain. At a minimum, the mitigation goal needs to be specific enough to reflect an intended level of mitigation.

8.2.2 Adoption of practices or technologies

The expected level of adoption of the practice or technology that is targeted by the policy can be used to estimate the maximum implementation potential. The main assumption would be that targeted stakeholders will fully engage voluntarily, or fully comply where the policy is mandatory.

Information about stakeholders can be obtained from the causal chain, the policy description and other sources. It can be used to infer the amount of land area or number of livestock affected by the policy, such as:

- the stakeholders targeted by the policy
- the average size of parcels of land owned or used by a stakeholder group
- the typical amount of forest products extracted or crops produced per person
- the number of cattle or other animals managed by stakeholders in a specific region.

8.2.3 Financial considerations

The cost of implementing mitigation practices or using technology (e.g. $/head to provide a feed supplement to livestock) can be compared with the total financing available for the policy to estimate the maximum implementation potential. Information on the unit cost of implementing technologies or practices might be available from studies that have been commissioned and funded by the government, an international organization or academia. Where unit cost information is not available, other sources can be used as a first approximation, including:

- consultations with stakeholders on costs in different parts of the country and for different activities (such information could also be derived from scientific journals)
- figures obtained from other marginal abatement cost-curve models, or from studies published in scientific journals.

Where unit cost figures are derived from global data, journals or studies relating to other countries, users should ensure that the information is suitable for their country or representative of national circumstances.

Users also need an indication of the financial resources that will be allocated to a specific policy from the national budget and other funding sources (e.g. private sector, national or international donors, international or regional funds) to estimate implementation potential from financial data. This information may be available from the description of inputs developed in Section 6.1.1, step 2.

The unit cost combined with the total investment level can be used to estimate maximum implementation potentials. For example, if a policy includes plans to invest $1 million in reforestation and it costs $100/ha to implement, the maximum implementation level of the policy can be estimated as 10,000 ha of reforestation. Ideally, this value would be reconciled with an estimate of maximum available area of land for reforestation using land area data to ensure that it is realistic to assume that at least 10,000 ha could be reforested.

Note that this analysis focuses on policy-level financing (e.g. national and sectoral level). A method is provided in Section 8.3 for assessing the financial feasibility of a policy from the perspective of landowners.

8.2.4 Land area and other resource potential

Analysing the availability of land is another way to estimate maximum implementation potential – that is, identifying the total area of land upon which there is technical potential for a specific mitigation practice or land-use change to occur. The assumption would be that all available land is affected by the change in management or land use as a result of the policy. For example, if a policy aims to convert highly degraded pasture to productive silvopastoral systems, and there is 50,000 ha of highly degraded pasture within the policy jurisdiction, the assumption would be that the policy will result in 50,000 ha of pasture used for silvopasture.

To use this approach for estimating maximum implementation potential, information on current land management and land uses is needed. Such data can be found in, or derived from:

- national land cadastre
- national agricultural census data
- land-use titles
- local or regional land registration offices
- farmer or logger associations
- logging permits
- timber harvesting statistics.

The technical potential of resources other than land area can be analysed to estimate adoption rates for new practices or technologies. For policies that reduce emissions from enteric fermentation, the total number of livestock in the country or the total number of ranchers could be used to analyse the maximum implementation potential. For example, if a policy seeks to increase use of feed supplements in dairy cattle, it can be assumed that all dairy cattle within the policy jurisdiction will receive the feed supplements as a result of the policy.

8.2.5 Expert judgment

Expert judgment can be paired with any of the approaches above to derive an informed estimate of the maximum implementation potential. Sector specialists (e.g. farmers, ranchers, foresters, scientists who study the technologies or practices promoted by a policy, statisticians, government staff who are familiar with the policy) can help to fill gaps in available data or provide a range for the maximum implementation potential. Experts can also help users identify suitable values of the policy outcome or policy effectiveness from estimated ranges. When consulting experts, information can be obtained through an expert elicitation process (described in Section 4.2.4).

8.2.6 Example of determining maximum implementation potential

Using the example scenario in Box 8.1, the PES policy has the goal to engage stakeholders in voluntary contracts with the Ministry of Environment to provide ecosystem services on a total of 60% of private forest lands and 25% of low-productivity cropland over 10 years. The specific aim is to implement SFM on private forest land and A/R activities on cropland. The maximum implementation potential is determined for the policy activities on each land category.

Based on data from the latest national forest census, the total area of privately owned forest land in the country is 250,000 ha; 60% of this area is 150,000 ha. From national agriculture statistics, it is known that the total area of low-productivity cropland is 240,000 ha; 25% of this is 60,000 ha. Therefore, over 10 years, the goal of the policy is for 150,000 more hectares of forest land remaining forest land to be brought into SFM and 60,000 more hectares of cropland to be converted to forest land as a result of the policy. The values can be annualized evenly over 10 years (e.g. 15,000 ha/year for 10 years), annualized following a non-linear trend based on estimated timing of implementation, or considered cumulatively (i.e. 150,000 ha total over 10 years). The land areas (150,000 and 60,000 ha, respectively) are considered as the maximum possible land areas for policy intervention.

Additional information in the policy design indicates that, to meet the goal of converting cropland to forest land, the policy aims to promote three types of practices: general tree planting, tree planting with endangered species and natural regeneration, with landowner payments for each practice of $1,000/ha, $1,500 /ha and $500/ha, respectively. Programme managers in the Ministry of Environment believe that most of the budget should go to funding natural regeneration because of its relatively low cost and comparable benefits to the other practices, and only a small share should fund tree planting with endangered species, with the remaining funding going to general tree planting. Based on these priorities, the total amount of land where each practice will be adopted as a result of the policy was estimated. Table 8.2 provides the maximum potential estimated land areas affected by the policy, by practice, cumulatively for the 20-year assessment period.

TABLE **8.2**

Example of maximum implementation potential

Policy activity	Maximum implementation potential (ha)
SFM	150,000
Tree planting general	15,000
Natural regeneration	40,000
Tree planting with endangered species	5,000

8.3 Account for policy design characteristics and national circumstances

It is a *key recommendation* to analyse policy design characteristics and national circumstances that may reduce the effectiveness of the policy, and account for their effect on the maximum implementation potential of the policy.

Section 8.3.1 provides a method for analysing policy design characteristics and national circumstances (step 1), and estimating their effect on maximum implementation potential (step 2). Section 8.3.2 provides some further considerations to help with this analysis. Section 8.3.3 provides a worked example to illustrate the steps.

8.3.1 Method for accounting for policy design characteristics and national circumstances

Step 1: Analyse policy design characteristics and national circumstances
Compile information on the policy design characteristics and national circumstances using the questions in Table 8.3. The questions relate to the effect of policy design characteristics and national circumstances on policy effectiveness. The questions can be revised, or further questions can be added, as needed, to ensure that the analysis is relevant to the policy and national circumstances.

Information can be gathered through expert elicitations with administration and government experts who are directly or indirectly involved in the policy under consideration, desk reviews and stakeholder consultations. Refer to the ICAT *Stakeholder Participation Guide* (Chapter 8) for further information on designing and conducting consultations with stakeholders.

Answer each question and score each response based on its potential to have a positive or negative effect on the effectiveness of the policy, on a scale of 1 to 4, as follows:

1 = Likely to have a positive (reinforcing) effect

2 = Likely to have no effect (no discernible positive or negative effect)

3 = Likely to have a negative effect

4 = Unknown.

Step 2: Evaluate the overall distribution of scores and estimate the effect on maximum implementation potential
Once policy design characteristics and national circumstances have been analysed and scored, evaluate the overall distribution of scores:

- A distribution with many scores of 1 or 2 indicates less need to refine the estimated maximum implementation potential of the policy.
- A distribution with many scores of 3 or 4 could suggest a downward adjustment of the maximum implementation potential, or a need to gather more information and reassess the impact, especially for scores of 4.

Carefully review each score of 3. Consider and, if possible, estimate to what extent the factor will decrease policy effectiveness. Describe and justify the reduction. In addition, look for crucial problems that have the potential to render the policy ineffective. If even one crucial problem is identified, it is recommended to reconsider the policy design. If possible, identify potential corrective action to minimize the negative impacts. For example, after following the method in this section, the user may reduce the geographic scope of impact, reduce the expected adoption rates or delay the timing of the implementation of a policy.

For scores of 4, attempt to gather enough information to assess the effect of the factor. If this is not possible, it is conservative to assume that the factor will have a negative effect.

A positive impact may reinforce the implementation of the policy through, for example, synergistic effects between policies. Where a situation may increase policy effectiveness, it is conservative to not estimate any potential positive impact or make any positive adjustments to the expected policy outcomes.

8.3.2 Considerations for accounting for policy design characteristics and national circumstances

This section describes a number of considerations to bear in mind when following the steps in Section 8.3.1.

TABLE **8.3**

Questions for identifying policy design characteristics and national circumstances

1. Institutional arrangements and national circumstances	
a.	Can the policy be implemented with existing governance structures, institutional arrangements and legal mechanisms?
b.	Is there corruption in the areas or regions under consideration? If so, how extensive?
c.	Do stakeholders receiving the benefits offered by the policy have clear title and rights?
d.	How well can the levels of governance that influence land use coordinate to achieve the intended outcome?
e.	How well can coordination (e.g. resources, enforcement, data sharing) be carried out at subnational levels (e.g. between local municipalities), if necessary, according to the policy?
2. Participation requirements	
a.	Is participation in, or compliance with, the policy voluntary or mandatory?
3. Compliance monitoring and enforcement	
a.	Is a monitoring programme planned or in place to assess policy implementation?
b.	Is an enforcement measure part of the policy? If so, to what degree are similar standards, rules and regulations enforced, and how?
4. Complementarity and synergies	
a.	To what extent will supporting or complementary policies and actions in effect during the policy implementation period improve policy effectiveness?
b.	To what extent is the policy part of an interdisciplinary approach linking food security, ecosystem services and/or sustainable development?
c.	Are supportive measures in place to build the capacity and technical skills of affected stakeholders who will be implementing the policy?
5. Policy implementation risks	
a.	To what extent are the intended policy outcomes vulnerable to risks (including natural events and disasters) that could jeopardize or reverse the policy outcomes?
b.	Have research and pilot studies been conducted in the areas where the policy will be implemented, and do they demonstrate that the expected outcomes of the policy are feasible?

Institutional arrangements and national circumstances

Institutional arrangements are formal or informal legal and procedural agreements between agencies executing a policy. They can include arrangements between government agencies, or between government and non-governmental or private sector agencies. National circumstances are the conditions present in the country. They include the government structure, population profile, cultural context, geographic profile, climate profile and structure of the economy.

Lack of a governance structure, lack of coordination between national and subnational levels, or lack of a legal basis for providing incentives to stakeholders are critical considerations that can inhibit the successful implementation of the policy if not addressed appropriately. Policies are likely to be limited in their effectiveness if countries do not have established institutional arrangements, or an effective legal framework to secure cooperation between different government levels and with key stakeholders (including private, public and non-governmental stakeholders).

Many ministries and other government agencies have difficulties in hiring and retaining staff, primarily because of budgetary and administrative constraints. Where staff and infrastructure (e.g. offices, equipment, vehicles, fuel) necessary for policy implementation are not in place before policy implementation, policy implementation may not move forward as expected, reducing the effectiveness of the policy.

Corruption in national or subnational government structures can also play a detrimental role in the implementation of the policy. Corrupt practices may involve politicians, local leaders, and government or non-governmental actors. They can result in implementation problems relating to land concessions, the allocation of contracts (e.g. favouring friends or relatives), allowing illegal practices (e.g. logging without permits), and misuse of funds intended for the policy.

Participation requirements

Participation in the policy, by people or organizations, can be voluntary or mandatory. Voluntary participation relies on the willingness of stakeholders to respond to a policy, offers flexibility in terms of who participates and how, and can involve less oversight and enforcement. In the absence of strong incentives, voluntary participation is unlikely to result in high participation and is more likely to result in a policy whose impacts are indistinguishable from the baseline scenario. Other factors that can help or hamper participation include effective communications and training for target stakeholder groups.

Mandatory participation can be accompanied by specific obligations and can be enforced through strict procedures, including penalties for non-compliance. Mandatory participation works better in cases where the progress of policy implementation can be effectively monitored and enforced. However, bribery and corruption could reduce the potential impact of the policy.

Compliance monitoring and enforcement

Monitoring and enforcement are mechanisms to compel stakeholders to comply with a policy. Monitoring is the process of inspecting that the policy is being implemented, and enforcement is an action taken against those who are not in conformance with the policy. The policy may include measures to monitor and/or enforce policy implementation.

When stakeholders understand that policy implementation will be monitored, it is more likely that implementation will occur. If monitoring procedures are already in place or are planned (e.g. because similar policies or projects already exist in a region), this should be taken into account, as it can help ensure that the policy is implemented effectively. In the absence of monitoring procedures, the policy may not be implemented as effectively as expected.

Local enforcement agencies and other stakeholders should be consulted to determine the likelihood that standards, rules or laws will be enforced. The likelihood of enforcement (e.g. 90% chance of enforcement) should be used to refine the implementation potential of the policy (e.g. reduce the impact by 10%). If penalties for non-conformance with the policy are minor, enforcement may not be as effective in ensuring compliance.

Complementarity and synergies

GHG mitigation policies that contribute to local sustainable development and promote better local conditions are far more acceptable to local communities, and usually have a far better chance of uptake and success. Examples of this type of policy are policies that have health benefits due to reduction of local air pollution, reduce loss of biodiversity, address desertification issues, protect water resources or improve food security for poor communities.

The implementation of GHG mitigation policies can be positively or negatively affected by other complementary policies. For example, a policy to reduce water pollution from agricultural run-off may drive changes in land management that reduce fertilizer use and increase use of cover crops, which are practices that can reduce nitrous oxide emissions from soils and increase soil carbon sequestration.

Interventions that provide education and technical assistance do not reduce GHG emissions directly. However, they may be pivotal in developing the capacity of land managers to implement technologies and practices that reduce GHG emissions. Therefore, the presence of such interventions can be synergistic with GHG mitigation policies.

Policy implementation risks
Agriculture and forest productivity are greatly impacted by weather conditions, climate and water. Food, forests and wood production are often impacted by natural events and disasters. For example, forest fires, floods, droughts, extreme weather events (e.g. hurricanes, tornadoes), diseases and pests can have negative consequences.

The assessment should consider the effect of natural events and disasters. If areas that are known to be prone to extreme conditions are included in the geographic scope of the policy, the expected implementation potential of the policy should be reduced because the policy may be ineffective in these areas. However, even if there is no previous history of disaster risk, users may still consider reducing the implementation potential of the policy to account for unanticipated disasters.

The evaluation should also consider the risk that the policy will not be as successful as anticipated in reducing GHG emissions as a result of limited data and research. For example, where research and pilot studies have not been conducted in the areas where the policy will be implemented, there is a risk that implementation and/or impacts of the policy will be hampered by lack of experience and proof of concept, and this could reduce policy effectiveness.

8.3.3 Example of accounting for policy design characteristics and national circumstances

The screening questions from Table 8.3 were reviewed, and policy design characteristics and national circumstances were analysed (step 1). The participation requirements category is evaluated from the perspective of voluntary participants in SFM and A/R, as well as from users of ecosystem services. An additional question was added to reflect this. Extensive consultation with experts resulted in the responses and scores shown in Table 8.4.

TABLE **8.4**

Example of accounting for policy design characteristics and national circumstances

1. Institutional arrangements and national circumstances		Score
a.	*Can the policy be implemented with existing governance structures, institutional arrangements and legal mechanisms?* Sufficient governance structures are in place to oversee the policy implementation.	2
b.	*Is there corruption in the areas or regions under consideration? If so, how extensive?* Corruption is confined to small communities where local leaders are known to receive bribes for favourable treatment of industry. Most of these communities are located in areas that are not easily accessible. After consulting with experts, it is assumed that participation in the most remote communities will not result in the expected policy outcomes. These communities comprise an estimated 2% of the SFM area and 1.5% of the A/R area considered.	3
c.	*Do stakeholders receiving the benefits offered by the policy have clear title and rights?* There is no legal basis for participation of the private sector in the PES programme. To address this, the policy defines a legal framework for the participation of private landowners.	2
d.	*How well can the levels of governance that influence land use coordinate to achieve the intended outcome?* With the exception of two regions, the government and local authorities have a good working relationship.	2
e.	*How well can coordination (e.g. resources, enforcement, data sharing) be carried out at subnational levels (e.g. between local municipalities), if necessary, according to the policy?* There are no subnational technical assistance or incentive programmes that conflict with the national policy.	2

TABLE **8.4,** continued

Example of accounting for policy design characteristics and national circumstances

	2. Participation requirements	Score
a.	*Is participation or compliance with the SFM and A/R activities voluntary or mandatory?* Because of voluntary participation, experts believe that 85% of the landowners originally considered will participate. These landowners account for 77% of the SFM area and 96.5% of the A/R area considered, without taking into consideration the area reduction due to aspect 1d above.	3
b.	*Is participation in, or compliance with, the policy voluntary or mandatory?* One out of the two hydroelectric utilities will not participate in policy implementation because operations will be suspended as a result of the 5-year drought that has reduced the river flows that power the hydropower station. That utility was expected to contribute to about 15% of the total revenue that was to be raised.	3
	3. Compliance monitoring and enforcement	
a.	*Is a monitoring programme planned or in place to assess policy implementation?* There is sufficient local enforcement capacity in the regions considered.	2
b.	*Is an enforcement measure part of the policy? If so, to what degree are similar standards, rules and regulations enforced, and how?* The Ministry of Environment will conduct annual audits on a random basis to monitor implementation of, and compliance with, best-practice standards for SFM, tree planting and natural regeneration.	2
	4. Complementarity and synergies	
a.	*To what extent will supporting or complementary policies and actions in effect during the policy implementation period improve policy effectiveness?* There are complementary activities to regulate water and reduce loss of biodiversity in the areas considered.	1
b.	*To what extent is the policy part of an interdisciplinary approach linking food security, ecosystem services and/or sustainable development?* There is a direct link to ecosystem services (PES scheme) and sustainable development, because the policy will provide resources to local communities and will contribute to stopping the degradation of the local environment.	1
c.	*Are supportive measures in place to build the capacity and technical skills of affected stakeholders who will be implementing the policy?* The policy incorporates educational programmes to raise awareness and build technical skills of local foresters.	1
	5. Policy implementation risks	
a.	*To what extent are the intended policy outcomes vulnerable to risks (including natural events and disasters) that could jeopardize or reverse the policy outcomes?* About 35% of the areas considered have experienced extreme weather events in the past five years.	3
b.	*Have research and pilot studies been conducted in the areas where the policy will be implemented, and do they demonstrate that the expected outcomes of the policy are feasible?* Scientific research in the National Study on Decarbonisation Strategies provides evidence that SFM and tree planting increase carbon sequestration.	1

The distribution of scores was evaluated (step 2). Of the 14 factors above, 10 received a score of 1 or 2, indicating that most factors considered are expected to have either a positive impact or no impact on the implementation potential of the policy. Four factors are likely to have a negative impact and received a score of 3. These related to corruption (1b), participation (2a and 2b) and policy implementation risks (5a). No factors had a score of 4.

The extent to which policy effectiveness may be reduced as a result of each factor was evaluated (step 2). None of the factors receiving a 3 appear to be crucial problems that could completely hamper policy effectiveness. The impact on policy effectiveness was adjusted quantitatively.[28]

The exclusion of communities with corruption problems (1b), the expectation of lower than planned voluntary participation of landowners (2a) and the potential risk of disasters (5a) will all result in an overall reduction in the area of land where the policy is effectively implemented. Table 8.5 summarizes the estimated extent to which these aspects will reduce policy outcomes.

The withdrawal of one hydroelectric utility (factor 2b) will reduce the expected tax revenue by 15% over 10 years. This reduction, however, is not expected to create a measurable impact because the overall SFM and A/R areas enrolled are also likely to be smaller than expected (based on the score for 2a). In any case, it would be desirable that other sources of revenue are identified to ensure that there will be no shortage of funding for the PES programme in the long term.

Complementarity and synergy factors 4a, 4b and 4c could create interest and possibly increase support from stakeholders and participation from landowners who see the benefits of the policy. However, the potential positive impact is not quantified.

At the end of the analysis, the maximum area affected by the policy has been adjusted to reflect the quantifiable impacts of lower than originally designed participation and expected policy outcomes. The results are shown in Table 8.6.

TABLE **8.5**

Example description and justification for reducing expected policy effectiveness

Description and justification	Reduction in policy effectiveness (%)	
	SFM	A/R
Participation in remote communities where corruption exists will not yield expected policy outcomes. These comprise 2% and 1.5% of the land areas for SFM and A/R targeted by the policy, respectively.	2	1.5
Experts estimate that only 85% of landowners offered the opportunity will participate because it is voluntary (77% of SFM; 96.5% of A/R).	23	0.5
35% of the area target by the policy has experienced extreme weather events in the past five years. Using information on the impacts of these past events, experts estimate that about 5% of land enrolled in the programme will experience catastrophic weather during the assessment period that could prevent achievement of the expected policy outcomes in those areas.	5	5
Total potential adjustment (percentage reduction in policy effectiveness)	30	7

[28] Where quantifiable information is not available, estimates of the impact on policy effectiveness may be made using expert judgment based on the best available information. Although it may be subjective, this is more conservative than not making an adjustment where the aspect considered is likely to have a negative impact.

TABLE **8.6**

Example of refined implementation potential

Policy activity	Maximum implementation potential (ha)	Refined implementation potential based on policy design and national circumstances (ha)
SFM	150,000	105,000
Tree planting, general	15,000	13,950
Natural regeneration	40,000	37,200
Tree planting with endangered species	5,000	4,650
Total	**210,000**	**160,800**

8.4 Account for financial feasibility

It is a *key recommendation* to analyse the financial feasibility of the policy for each stakeholder group and account for the effect on the implementation potential of the policy.

Financial feasibility analysis determines whether enough money is being invested in the policy to ensure that stakeholders will participate or otherwise respond to the policy. The effectiveness of a policy can be reduced if its implementation costs outweigh its benefits for a given stakeholder critical to the implementation of the policy.

There is no single way to perform a financial feasibility analysis. It may take the form of a complex and rigorous assessment (e.g. a detailed financial return-on-investment model) or a simple analysis (e.g. a checklist of financial costs and benefits). Users should determine the specific type of analysis based on the data available.

Sources of information for conducting financial feasibility are, in order of preference:

- existing calculations of the costs and benefits of policies for an individual stakeholder that were done during the policy design phase (as long as these are deemed reliable)
- implementation cost analyses
- exiting national cost studies
- global cost studies
- expert judgment based on assessments or desk review.

In the absence of other available resources, the sections below provide a method for performing a basic cost analysis. Section 8.4.1 provides a method for analysing financial feasibility. Section 8.4.2 provides some further considerations to help with this analysis. Section 8.4.3 provides a worked example to illustrate the steps.

Before starting the cost analysis, some questions should be considered:

- Do some stakeholders bear significant new net costs under the proposed policy? If so, which stakeholders and what are the costs?
- Do some stakeholders realize significant new net financial gains under the proposed policy? If so, which stakeholders and what are the gains?
- What goods and services are produced commercially from lands that are the target of the policy, both before and after policy implementation? Is production likely to increase or decrease as a result of the policy?

- Is the policy potentially in conflict with economic development?
- Will the policy strengthen important supply chains?

8.4.1 Method for accounting for financial feasibility

Step 1: Identify stakeholder groups to analyse
In Section 6.1.1, users identified the stakeholders of the policy. These stakeholders are the focus of this analysis, particularly stakeholders who implement changes in practices, technologies or land use in response to the policy. Each stakeholder group should be included in the financial feasibility analysis, and the net costs and benefits for each group should be considered separately. Where insufficient data and information are available to analyse all stakeholder groups separately, at least include the following groups in the analysis:

- stakeholders with official land tenure rights or de facto control of land addressed by the policy
- stakeholders who use the land addressed by the policy but have limited actual control over the land.

It can be difficult to distinguish between stakeholders with official tenure to land and stakeholders who use the land affected by the policy without tenure. In such cases, focus on the main stakeholder group that is expected to implement the mitigation measures.

Step 2: Calculate net cash flows for each stakeholder group
In a basic implementation cost analysis, net cash flows are estimated for a typical stakeholder in each stakeholder group under baseline and policy scenarios. It is best if the financial feasibility analysis is done in the local currency. If foreign investment is required or if loans are denominated in a foreign currency, it is still best to do the analysis in the local currency and then convert the results to the foreign currency. Often some factors will be in foreign currency. In this case, the exchange rate should be entered in only one location in the analysis calculations, so that the entire analysis can be updated by changing the exchange rate at that location if the exchange rate changes. If the analysis is done in a foreign currency, there is a risk of currency fluctuations altering the conclusions of the analysis.

Where inflation is likely (e.g. over longer periods of time), apply a discount rate and calculate a net present value for the cash flows to take into account the future value of money. Non-discounted values can be used if inflation is not likely during the analysis period (e.g. five years or less). Table 8.7 provides more information on metrics for financial analysis.

Different stakeholders should have different discount rates. For example, the discount rate for a government is generally much lower than the discount rate for a corporation, and the discount rate for a corporation that has access to capital is often much lower than the discount rate of a smallholder farmer. Appendix B provides additional information on discount rates.
To enable comparison between stakeholder groups, the costs should be normalized (e.g. per hectare, per operation, per head of livestock, per person).

The following process is used to estimate net cash flows:

1. Estimate baseline scenario costs and revenues using present-day data for a typical stakeholder who will take part in the policy, and repeat this for each stakeholder group. Take into account how the land area under consideration would be used without the policy (e.g. what is produced on the land and how much, considering, for example, animal farming, croplands, set-asides or logging).

   Average cost and revenue figures can be used for groups of land categories. For example, use average expense and income from all cropland areas (irrespective of the type of the crop); group together fallow land and set-asides, and derive average values for those lands; or use national statistics and prices on average timber harvest.

   Include costs of inputs and costs of production, in addition to revenues from sale of goods. Key input costs include raw materials, equipment, labour, permits to operate, and other costs entailed in producing and selling the goods. For example, costs in agriculture include fertilizer and seed for crops, fencing for cattle, feed, feed additives and medications. Input costs may include taxes on operations or land that must be paid from revenues from the sale of goods.[29]

[29] The European Commission *Guide to Cost Benefit Analysis of Investment Projects* (EC, 2008) can be a useful resource for how to identify costs and revenues, calculate discounted cash flows, and implement other aspects of financial and economic feasibility analysis.

TABLE **8.7**

Definitions of common terms used in financial analysis

Term	Definition
Cash flow	The net amount of cash and cash equivalents moving into and out of a business. Positive cash flow indicates that a company's liquid assets are increasing, enabling it to settle debts, reinvest in its business, return money to shareholders, pay expenses and provide a buffer against future financial challenges. Negative cash flow indicates that a company's liquid assets are decreasing. Some stakeholders will not implement an action that has a negative net cash flow at any time.
Discount rate	The interest rate that needs to be earned on a given amount of money today to end up with a given amount of money in the future. The discount rate accounts for the time value of money, which is the idea that a dollar today is worth more than a dollar tomorrow, given that the dollar today has the capacity to earn interest.
Present value	The current worth of a future sum of money or stream of cash flows given a specified discount rate. Future cash flows are discounted at the discount rate. The higher the discount rate, the lower the present value of the future cash flows.
Rate of return	The gain or loss on an investment over a specified time period, expressed as a percentage of the investment's cost. Gains on investments are defined as income received plus any capital gains realized on the sale of the investment. The general equation for the rate of return is: (gain of investment – cost of investment) / cost of investment

Source: Adapted from Investopedia (2017).

2. Estimate the baseline scenario net cash flow (i.e. revenues minus costs) over the assessment period, separately for each stakeholder group.

3. Estimate the policy scenario costs and revenues over the assessment period, separately for each stakeholder group. This includes determining

   » the amount and type of government or private funding committed to implementing the policy
   » the cost to the stakeholder to implement the policy
   » the revenues that the stakeholder will gain from the policy.

4. Estimate the net cash flow for a typical stakeholder in the policy scenario, separately for each stakeholder group.

Step 3: Assess financial feasibility
Compare the net cash flow for the baseline scenario with that for the policy scenario to assess financial feasibility, as follows:

1. Determine whether the total net cash flow for the policy scenario exceeds the net cash flow for the baseline scenario. This must be the case for the policy to be financially feasible.

2. Determine whether the total net cash flow for the policy scenario is positive. This must be the case for the policy to be financially feasible.

3. When the net cash flow for the policy scenario is positive, compare the discounted cash flow (net present value) and rate of return (for the general formula, see Table 8.7) in the baseline and policy cases. For the policy to be financially feasible, the rate of return on the policy case must be higher than the baseline rate of return by more than 3 percentage points.

Repeat this analysis for each stakeholder group identified and all activities covered by the policy.

Step 4: Estimate the extent to which financial aspects will limit policy outcomes
Based on the results of the financial feasibility assessment, decide how the implementation potential of the policy will be affected, as follows:

- Where the policy does not appear to provide sufficient incentive for stakeholders to participate or otherwise respond to the policy, either reconsider the design of the policy (or the relevant component of the policy) or refine the implementation potential of the policy.
- Where the policy appears to provide sufficient incentive for stakeholders to participate or otherwise respond to the policy, continue to the next step without revising the implementation potential of the policy.

8.4.2 Considerations for accounting for financial feasibility

Below are additional considerations when deciding how the implementation potential of the policy will be affected:

- In addition to discounted costs and revenues, the financial analysis should consider the relative timing of costs and revenues, and the capital needed to achieve these cash flows. If costs occur before revenues, stakeholders must have access to funds to pay the costs or they may not behave as expected.

  Shifts in timing of returns can be large for A/R. There are considerable costs in establishing stands of trees, but there may be negligible revenues for years while the trees grow to have commercial value. As a result, many forestry projects are only financially feasible with low discount rates. For entities with high discount rates, such as most smallholder farmers, even modest seasonal delays in revenue relative to expenditures can create a significant barrier to implementation. Delaying the harvest season can be a barrier to food-insecure households that do not have other crops to eat during the delay.
- In general, unless the policy increases net revenue to stakeholders, or reduces their risks, the policy is unlikely to be adopted voluntarily.

  Policies that provide a net financial benefit may have little incentive for adoption if the net gain is small relative to overall cash flows.
- Investors, farmers, landowners and other stakeholders are often risk averse. Some policies offer stakeholders a positive financial return, yet still fail to be adopted, because stakeholders view returns as too uncertain or risky. For example, they may not be confident that payments in the future will be made, contracts will be honoured, or the policy will have ongoing political and budgetary support. As a result, assessing simple return on investment alone may not give a reliable indication of the likelihood of policy adoption. Financial risk can be quantitatively incorporated into the analysis by increasing stakeholders’ discount rate, or qualitatively considered by consulting stakeholders on their likely response to specific real-world policy incentives.
- Some changes may have costs that are not obvious. For example, a change may involve significant management labour costs to revise organizational processes or train new workers who are needed to provide different skills in the organization.
- It may be important to identify other financial considerations, and sectoral policies and trends that may affect the financial feasibility of the policy, and to consider whether these reinforce or counteract the intended implementation (e.g. through price signals and consumer behaviour).

When a government is considering what policies to adopt, it may also want to consider the financial effects on society as a whole. Such an evaluation is beyond the scope of this methodology.[30]

8.4.3 Example of accounting for financial feasibility

To estimate net cash flows, data on a per-hectare basis are used for annual costs and benefits for land areas affected by the policy, from the perspective of stakeholders managing the land. For this example, a cost analysis is conducted for tree planting activities on cropland. The example considers the first 10 years

[30] A variety of sources are available that provide guidance on estimating net economic effects on society, including EC (2008).

of policy implementation after the conversion of agricultural land into forest land, representing enough time to complete a harvest cycle and realize the value of timber from the planted trees.

The costs and revenues for the baseline scenario are estimated in Table 8.8. The baseline scenario assumes that there will be a continuation of current agricultural production for the next 10 years (constant baseline). The table presents annual data for year 1, years 2–9 and year 10 of the policy. Negative numbers represent costs (expenses), and positive numbers represent revenues (income).

Table 8.8 provides average present-day estimates for costs and revenues per hectare under the baseline scenario. The costs identified were farming labour; crop inputs (seed, fertilizer, equipment, fuel); and land cost, taxes and concession fees. The revenues identified include all income from selling the crops. The costs and revenues were kept constant for all 10 years. Based on these assumptions, a typical farmer has net annual revenues (or cash flow) of \$50/ha. Applying a discount rate of 15% reduces the annual revenue from \$50/ha in year 1 to \$14/ha by year 10.

Next, the costs and revenues for the policy scenario are estimated (Table 8.9). Under the policy scenario, the same cropland area is converted to forest land through general tree planting.

Table 8.9 provides average present-day estimates for costs and revenues per hectare under the policy scenario. The costs identified are planting cost for trees; land costs, taxes and concession fees; and stand management and harvest costs. It is anticipated that the farmer would have planting costs for year 1 (\$1,000/ha), stand management costs for years 2–9 (\$10/ha) and harvest costs for year 10 (\$12,000/ha, assuming a harvest of 50 m^3/ha, a harvest cost of \$100/m^3, a processing cost of \$50/m^3, and transport and tax cost of \$100/m^3).

The revenues identified include government support for the planting of all trees in year 1 (\$1,000/ha) and income from selling the harvested timber in year 10 (assuming a harvest of 50 m^3/ha, and a price of \$300/m^3).

Comparison of discounted net revenues in the baseline (\$289/ha) and policy (\$665/ha) scenarios indicates that general tree planting activities may be profitable for farmers (Tables 8.8 and 8.9). The

TABLE **8.8**

Example calculation of baseline costs and revenues for continuation of agricultural production

Costs and revenues	Annual costs and revenues ($/ha) for year			Total
	1	2–9[a]	10	
Costs				
Farming labour	–100	–100	–100	
Crop inputs (seed, fertilizer, equipment, fuel)	–100	–100	–100	
Land cost, taxes and concession fees	0	0	0	
Total cost	**–200**	**–200**	**–200**	
Revenues				
Crop revenues	250	250	250	
Net farming revenue, undiscounted	**50**	**50**	**50**	**500**
Net farming revenue, present value	**50**	**[43–16]**	**14**	**289**

[a] For simplicity, individual values for each year are not shown. Square brackets indicate the range of values during that time period. That is, [43–16] means that values range from \$43/ha in year 2 to \$16/ha in year 9.

TABLE **8.9**

Example calculation of policy scenario costs and revenues for general tree planting

Costs and revenues	Annual costs and revenues ($/ha) for year			Total
	1	2–9[a]	10	
Costs				
Planting cost	–1,000	0	0	
Land costs, taxes and concession fees	0	0	0	
Stand management and harvest cost	0	–10	–12,500	
Total cost	**–1,000**	**–10**	**–12,500**	
Revenues				
Timber	0	0	15,000	
Government payments for planting	1,000	0	0	
Government livelihood support	0	0	0	
Total revenue	**1,000**	**0**	**15,000**	
Net tree planting revenue, undiscounted	**0**	**–10**	**2,500**	**2,420**
Net tree planting revenue, present value	**0**	**[–9 to –3]**	**711**	**665**

[a] For simplicity, individual values for each year are not shown. Square brackets indicate the range of values during that time period.

net cash flow in the policy scenario is positive and exceeds the net cash flow in the baseline scenario. In both cases, the net revenue after 10 years of tree planting would be significantly higher than the net farming revenue.

However, yearly cash flow trends in the policy scenario show a net loss of income for 9 out of the 10 years of policy implementation. Because of this, some farmers may decide not to participate. Other farmers may be able to wait until year 10 for the revenue from selling the harvested timber and would be more likely to participate. Without more information or refining of the policy design, participation is likely to be highly situational and difficult to predict.

Given this uncertainty, the policy design is reconsidered, and an alternative scenario explored. The alternative scenario is for the government to provide a low–interest rate (e.g. 4%) annual loan payment to compensate for the lost revenue ($50/ha/year) (see Table 8.10). The loan provides the farmer with annual income (although less than the baseline case), and the total loan value can be repaid from timber sale revenues in year 10. If the policy is modified this way, broad participation in the programme is more likely. Table 8.10 demonstrates the costs and revenues of the redesigned policy for general tree planting with a low–interest rate loan.

Net cash flow estimates were made for natural regeneration and tree planting with endangered species for the A/R policy scenario (not shown), using the same constant baseline scenario as in Table 8.8 (continuation of current agricultural production for the next 10 years). Net cash flow estimates were also made for implementing SFM on privately owned forest land, where the constant baseline is the continuation of current forest management practices (not shown).

TABLE **8.10**

Calculation of policy scenario costs and revenues for general tree planting with a low-interest rate loan

Costs and revenues	Annual costs and revenues ($/ha) for year 1	2–9[a]	10	Total
Costs				
Planting cost	–1,000	0	0	
Land costs, taxes and concession fees	0	0	0	
Stand management and harvest cost	0	–10	–12,500	
Total cost	**–1,000**	**–10**	**–12,500**	
Revenues				
Timber	0	0	15,000	
Government payments for planting	1,000	0	0	
Government livelihood support	50	50	–1,300	
Total revenue	**1,050**	**50**	**13,700**	
Net tree planting revenue, undiscounted	**50**	**40**	**1,200**	**1,570**
Net tree planting revenue, present value	**50**	**[35–13]**	**341**	**571**

[a] For simplicity, individual values for each year are not shown. Square brackets indicate the range of values during that time period.

After considering all proposed activities, and adjusting some policy design aspects as described above, the policy was determined to be financially feasible for general tree planting and tree planting with endangered species. For SFM and natural regeneration, the policy scenario does not generate more revenue for landowners. Therefore, the policy design was modified further to increase payments for SFM and natural regeneration, maintaining the overall budget level. To achieve this, the area of land targeted for SFM and natural regeneration will be reduced by 10%. This will result in the total land areas shown in Table 8.11.

TABLE **8.11**

Refined implementation potential after financial feasibility analysis

Policy activity	Maximum implementation potential (ha)	Refined implementation potential based on policy design and national circumstances (ha)	Refined implementation potential based on financial feasibility (ha)
SFM	150,000	105,000	94,500
Tree planting, general	15,000	13,950	14,250
Natural regeneration	40,000	37,200	33,480
Tree planting with endangered species	5,000	4,650	4,750
Total	**210,000**	**160,800**	**146,580**

8.5 Account for other barriers

It is a *key recommendation* to analyse other barriers that could reduce the effectiveness of the policy and account for their effect on the implementation potential of the policy. This analysis is similar to that in Section 8.3 but focuses on institutional, cultural and physical barriers that may limit effectiveness of the policy.

Section 8.5.1 provides a method for analysing these other barriers and estimating their effect on the implementation potential of the policy. Section 8.5.2 provides some further considerations to help with this analysis. Section 8.5.3 provides a worked example to illustrate the steps.

8.5.1 Method for accounting for other barriers

Step 1: Analyse institutional, cultural and physical barriers
Compile information on the barriers identified in Table 8.12 and consider how these barriers may affect the implementation potential using the questions provided. The questions can be adapted, or further barriers and questions can be added, as needed, to ensure that the analysis is relevant to national circumstances.

Information can be gathered through expert elicitations with administration and government experts who are directly or indirectly involved in the policy under consideration, as well as through desk reviews and additional stakeholder consultations. Refer to the ICAT *Stakeholder Participation Guide* (Chapter 8) for further information on designing and conducting consultations.

Answer each question and score each response based on its potential to limit the effectiveness of the policy, on a scale of 1 to 4, as follows:

1 = Likely to have no effect

2 = Likely to limit effectiveness

3 = Likely to prevent implementation

4 = Unknown.

Step 2: Evaluate the overall distribution of scores and estimate the effect on implementation potential
Once each barrier has been analysed and scored, evaluate the overall distribution of scores:

- A distribution with many scores of 1 indicates less of a need to refine the implementation potential of the policy.

TABLE **8.12**

Other barriers to policy implementation

1. Institutional barriers	
a.	Are there any conflicting goals or jurisdictions between ministries or other agencies with respect to implementation of the policy?
b.	Is there the potential for institutional racism, gender bias or age discrimination that could limit the effectiveness of the policy – for example, by limiting participation of certain stakeholders based on their race, religion, gender or age?
2. Cultural barriers	
a.	Are different languages used in the region where the policy will be implemented?
b.	Is the policy congruent with cultural norms and values?
c.	Are there gender issues in accessing resources or communication?
d.	Are there generational differences in work ethics and work approaches that could result in conflicts or disputes among stakeholders that might limit the ability to effectively implement the policy?
e.	Are there any areas or landmarks with religious significance in the region under consideration?
f.	Is there a group that has very strong opposition to the policy?
3. Physical barriers	
a.	Are land areas proposed for intervention easily accessible?
b.	Is the necessary physical infrastructure in place for the proposed policy?
c.	Are there any war conflicts in the country that would limit access to certain land areas?

- A distribution with many scores of 2, 3 or 4 could suggest a downward adjustment of the implementation potential, or a need to gather more information and reassess the impact, especially for scores of 4.

Carefully review each score of 2 and 3. For a score of 2, consider and, if possible, estimate to what extent the barrier will decrease policy effectiveness. Describe and justify the reduction. For a score of 3, the barrier is considered crucial and has the potential to render the policy ineffective. If even one crucial barrier is identified, it is recommended to reconsider the policy design and discontinue the impact assessment. For scores of 4, attempt to gather enough information to assess the effect of the barrier. If this is not possible, it is conservative to assume that the factor will limit effectiveness of the policy.

Consider and determine to what extent the effects of barriers overlap. An overlapping effect occurs where one barrier limits implementation in one area and another barrier limits implementation in the same area. These overlapping effects should be appropriately accounted for when calculating the potential effect of all barriers. The combined effect of the barriers may be greater than or less than the sum of the individual barriers. If information is available, uncertainty ranges should also be incorporated in the final results.

During the data-gathering phase, it is recommended that information also be collected on any other relevant policies in the country that might help overcome specific barriers. Where such policies exist, the scoring of the barrier effect should be changed accordingly (most likely to a score of 1).

8.5.2 Considerations for accounting for other barriers

Institutional barriers

Conflicting goals between different ministries and other government agencies could result in overlapping regulation, and ambiguous roles and responsibilities of the stakeholders involved. For example, proposed areas for the policy may overlap with other existing types of area protection (e.g. based on national policies or international conventions), which could lead to confusing regulations for specific sites.

Institutional barriers involving discrimination often include selection approaches that are not based on the actual performance of individual workers but are affected by racism, gender bias, age discrimination, favouritism and other factors. Where discrimination is present, certain stakeholders may not have equal access to the opportunities afforded by a policy (e.g. incentive payments, technical assistance, education), and this can limit overall effectiveness of the policy. Often such barriers are linked to corrupt practices (addressed in Section 8.3). Safeguards to prevent discrimination can be built into policies. For example, it can be required that enrolment in programmes such as education opportunities must be diverse in terms of race and gender. If safeguards against discrimination do not exist, either as part of the policy being analysed or in institutions involved in implementing the policy, it is possible that discrimination will be a barrier to policy implementation.

Cultural barriers

The use of language and terminology that is not widely understood by the target stakeholders could be a crucial cultural barrier because it could result in communication problems that lead to misunderstandings, mistrust, and non-participation or non-compliance among the local population. Where language barriers exist and there is no mechanism in place to overcome them, the effectiveness of the policy is likely to be reduced.

In many countries, successful implementation of GHG mitigation policies may require consideration of gender or social class sensitivities to reduce resistance of local communities to the proposed intervention. Cultural preferences may have more potential for change than physical limits, but change may take time and almost certainly will benefit from considering existing mechanisms of social influence. There may also be generational differences in work ethics and work approaches that have the potential to result in conflicts between older and younger workers. If the policy is sensitive to such factors, including potential language barriers, age distribution and cultural norms of stakeholders, they may not present a barrier to implementation.

In some countries, gender considerations can have a very important effect on the success or failure of implementation of the policy. It is important to consider who makes decisions about land-use actions, and who has access to information and money. For a policy to be implemented effectively, the person who is responsible for managing land will also need to have access to information and financing to implement management changes. If they do not, this will likely limit policy effectiveness.

Certain land areas or landmarks have important religious significance for local communities. Policies that may affect ancestral homes or sacred grounds are more likely to face resistance from indigenous peoples and local communities.

Strong opposition to a policy – for example, from a particular stakeholder group or political party – could hamper efforts to secure financing, gain trust and otherwise implement policy interventions, especially if that group is influential.

Failure to identify and address cultural barriers will more than likely have detrimental impacts on policy implementation. Effective stakeholder participation from early in policy design is important to identify and address cultural barriers. Refer to the ICAT *Stakeholder Participation Guide* for further information about all elements of effective stakeholder participation for policy design, implementation and evaluation.

Physical barriers

In mountainous countries or countries with inaccessible regions, policies relating to agriculture and forests should take into account whether certain land areas are remote or difficult to access. Minimal existing road networks or insufficient transportation infrastructure would be expected to limit the implementation potential of the policy.

Conflicts in a country (such as civil war or territorial disputes with a neighbouring country) could limit access to areas that could be considered for policy intervention. Depending on the severity of the conflict, and to safeguard the welfare of the people involved, certain parts of the country may be excluded until the conflict is resolved. This would reduce the impact of the policy, at least while conflicts remain active, and possibly longer.

8.5.3 Example of accounting for other barriers

The screening questions from Table 8.12 were reviewed (step 1). Not all of the screening questions were relevant, and a few of the questions were modified to suit national circumstances. The barriers under the cultural barriers category that related to cultural norms and values (2b), gender issues (2c), generational differences (2d) and areas of religious significance (2e) were considered collectively. The barriers under the physical barriers category that related to accessibility of land area (3a) and availability of infrastructure (3b) were also considered jointly. With these modifications, a total of seven barriers were considered. In consultation with experts, responses were tabulated and scored in Table 8.13.

TABLE **8.13**

Example of accounting for other barriers

	1. Institutional barriers	Score
a.	*Are there any conflicting goals or jurisdictions between ministries or other agencies?* The Ministry of Natural Resources has recently initiated a project, as a result of national legislation, in a land area covering about 25,000 hectares to address loss of biodiversity concerns. The same area is also considered for this project.	4
b.	*Is there the potential for institutional racism, gender bias or age discrimination that could limit the policy effectiveness – for example, by limiting participation of certain stakeholders based on their race, religion, gender or age?* The policy is in accordance with recent national legislation that has been put in place to eliminate discrimination in the workplace.	1
	2. Cultural barriers	
a.	*Are different languages used in the region where the policy will be implemented?* French and English are the two most widely spoken languages. However, several local isolated communities use their own dialects. Most local offices have sufficient capacity to communicate in these dialects.	1
b.	*Is the policy congruent with cultural norms and values?* Several local communities rely on hierarchical authority to make decisions on the use of their forest land. This is made possible in part by the age distribution of the communities. In most rural areas, the population is rather aged (average age of farmers: 45 years). Most young people move to urban areas in search of work because of a lack of job opportunities in the countryside. As a result, there is very little conflict about how to manage natural resources, with decisions made by elders largely carried out by the community leaders without question. Therefore, there are no cultural barriers related to generational differences.	1
c.	*Are there gender issues in accessing resources or communication?* See b above.	–
d.	*Are there generational differences in work ethics and work approaches that could result in conflicts or disputes among stakeholders that might limit the ability to effectively implement the policy?* See b above.	–
e.	*Are there any areas or landmarks with religious significance of the region under consideration?* See b above.	–
f.	*Is there a group that has very strong opposition to the policy?* No indications of groups that oppose the policy; however, information is very limited.	4

TABLE **8.13,** continued

Example of accounting for other barriers

3. Physical barriers		Score
a.	*Are land areas proposed for intervention easily accessible?* About 96% of the land area targeted by the policy is accessible. However, as a result of recent floods and soil erosion in the northern part of the country (accounting for about 35% of the land area under consideration), some roads will need to be inspected and repaired. According to expert judgment, it is too expensive, and there is currently no budget, to build roads. Therefore, about 6,400 ha of land originally targeted by the policy will not be accessible. Based on current land use in the impacted areas, it is estimated that half would have been used for natural regeneration and the other half for SFM under the PES programme.	2
b.	*Is the necessary physical infrastructure in place for the proposed policy?* See a above.	–
c.	*Are there any war conflicts in the country that would limit access to certain land areas?* There are no conflicts in the country.	1

Abbreviation: –, not applicable

The distribution of scores was evaluated (step 2). Four barriers received a score of 1. One barrier received a score of 2. Two barriers received a score of 4. None of the barriers received a score of 3.

The extent to which policy effectiveness may be reduced as a result of each barrier was evaluated. Five of the barriers are not expected to limit policy effectiveness. None of the barriers received a 3 (i.e. appear to be crucial problems that could completely hamper policy effectiveness). Physical barrier 3a will reduce the area of land available for SFM and natural regeneration by 3,200 ha. Any potential conflicts with the biodiversity project are unknown at this point because no details are yet available on how the project will be implemented, and what sort of criteria it will have for management and land use.

Based on the above assessment, the land area of the policy will be adjusted as shown in Table 8.14.

The table illustrates how land area was refined after each step. The refined values in the last column are considered the likely implementation potential of the policy, which are the values that should be used to estimate the GHG impacts of the policy.

8.6 Estimate GHG impacts

It is a *key recommendation* to estimate the GHG impacts of the policy. There are two ways to estimate GHG impacts: the emissions approach and the activity data approach. Where baseline emissions were estimated, users can calculate the change in emissions between the baseline and policy scenarios (emissions approach). Where baseline emissions were not estimated, the GHG impacts can be estimated by calculating the net GHG emissions reductions and removals directly from the likely implementation potential of the policy (activity data approach). A method for estimating the GHG impacts for each approach is given below.

8.6.1 Emissions approach

Users should use the likely implementation potential of the policy (derived following the method in Sections 8.2–8.5) to determine the most likely policy scenario. This involves deriving new parameter values and, if relevant, new emission factors that reflect conditions under the policy scenario. Box 8.2 provides an example of how emission factors were selected in the impact assessment of a NAMA.

The adjusted values and emission factors are used to estimate GHG emissions of the policy scenario. This involves subtracting the policy scenario emissions and removals from the baseline emissions and removals to estimate net change in GHG emissions and removals resulting from the policy.

TABLE **8.14**

Example of refined implementation potential

Policy activity	Maximum implementation potential (ha)	Refined implementation potential based on policy design and national circumstances (ha)	Refined implementation potential based on financial feasibility (ha)	Refined implementation potential based on barriers (ha)
SFM	150,000	105,000	94,500	91,300
Tree planting, general	15,000	13,950	14,250	13,950
Natural regeneration	40,000	37,200	33,480	30,280
Tree planting with endangered species	5,000	4,650	4,750	4,750
Total	**210,000**	**160,800**	**146,580**	**140,280**

BOX **8.2**

Example of selecting emission factors for estimating GHG impacts

The Grupo Ecológico Sierra Gorda, a national NGO in Mexico, is coordinating the implementation of the NAMA – Subnational Mitigation Actions for the Regeneration of Landscapes. The NAMA includes state-led policies and actions for the regeneration of forests and the implementation of planned grazing in 12 states.

One of the subnational actions for the regeneration of forests is to provide payments for ecosystem services to forest owners in exchange for the removal of cattle and other degradation factors from their forests. To assess the GHG impacts of pilot activities using the activity data approach described in the ICAT *Forest Methodology*, the Grupo Ecológico initiated local studies in conjunction with the Postgraduate College in Agricultural Science, with the support of the United States Forest Service and the State Secretariat of Sustainable Development. The studies include sampling of forest parcels that are regenerating following the removal of cattle, and of control sites that are still subject to cattle grazing. The studies seek to develop local emission factors for forest carbon capture resulting from natural regeneration. Initial results from these studies were used to assess GHG impacts in the forest understorey. It is expected that the studies will provide emission factors for other strata in the future.

To be consistent with national reports, data from the local study were complemented by the use of emission factors from Mexico's most recent national communication and biennial update report submitted to UNFCCC. In some cases, emission factors were also extrapolated from annual growth increments reported in state forest inventories or by state forestry departments.

8.6.2 Activity data approach

The likely implementation potential of the policy represents the effects that are expected to occur as a result of the policy. Implicitly, these effects are relative to the baseline scenario. The method below should be used to calculate the impact of the policy on each GHG source and carbon pool in the GHG assessment boundary. The GHG impacts for all GHG sources and carbon pools are summed to yield total policy impact on GHGs.

Estimate carbon stock change

Using the estimates of how much the policy will increase or decrease the area of land (hectares) in land categories affected by the policy (determined following the method in Sections 8.2–8.5), subdivide the land categories into strata according to the method in Section 7.2.2. These are the policy scenario strata.

Determine the policy impact on each GHG source and carbon pool included in the GHG assessment boundary for each policy scenario stratum. Methods for estimating the GHG impacts of the living biomass carbon pool are provided in the relevant sections below. Repeat the steps for each policy scenario stratum.

Forest land remaining forest land

- Step 1: Estimate the hectares of land in the policy scenario stratum for each year of the assessment period. Unless the policy design indicates otherwise, assume that the area of land changes following a linear trend. For example, in the forest policy example, the implementation potential for SFM is estimated as 97,400 ha over 15 years. A linear trend assumes that 6,300 ha of forest is affected by the policy each year for 15 years (i.e. management changes to sustainable forestry on 6,300 ha/year for 15 years). The assessment period is 20 years; therefore, for the last five years of the time series, no further hectares of forest are affected by the policy. Table 8.15 provides an example land area time series.

- Step 2: Calculate the annual carbon stock change for living biomass for the policy scenario stratum based on the land area time series estimated in step 1 and the method in Section 7.2.4 for forest land remaining forest land. Call this term $\Delta C_{\text{biomass with policy}}$ (units are tonnes C/year).

- Step 3: Determine the baseline scenario stratum, which is the most likely stratum if the policy were not enacted ("without policy"). The ecological zone in the baseline stratum should be the same as in the policy scenario stratum. The baseline management category should be different from the policy scenario stratum. To use this equation for the activity data approach, assume that the baseline land area time series is identical to the policy scenario land area time series developed in step 1 because it represents the same land as the policy scenario under an alternative scenario. Calculate the annual carbon stock change in living biomass for the baseline stratum based on the land area time series estimated in step 1 and following the method in Section 7.2.4 for forest land remaining forest land. Call this term $\Delta C_{\text{biomass without policy}}$ (units are tonnes C/year).

- Step 4: Calculate the cumulative carbon stock change over all years of the assessment period, separately for the baseline and policy strata.

- Step 5: Subtract the baseline cumulative carbon stock change from the policy cumulative carbon stock change to yield the policy impact on the living biomass carbon pool for the land strata.

TABLE **8.15**

Example land area time series

Year	1	2	3	4–13[a]	14	15	16	17	18	19	20
Area (ha)	6,300	12,600	18,900	[25,200–81,900]	88,200	94,500	94,500	94,500	94,500	94,500	94,500

[a] For simplicity, individual values for each year are not shown. Square brackets indicate the range of values during that time period.

Non-forest land converted to forest land

- Step 1: Estimate the cumulative hectares of land in the policy scenario stratum for the assessment period. For example, in the forest policy example, it is estimated that 14,250 ha of cropland will be converted to forest land through general tree planting as a result of the policy. Therefore, the cumulative hectares of land in the policy scenario stratum for non-forest land converted to forest land is 14,250 ha.

- Step 2: Calculate the change in forest carbon stocks from land conversion using equation 7.1 in Section 7.2.4. Set the area term in equation 7.1 equal to the hectares of land from step 1. This yields the policy impact on the living biomass carbon pool for the land stratum.

Reduced forest land conversion to non-forest land

- Step 1: Estimate the cumulative hectares of land in the policy scenario stratum for the assessment period. For reduced deforestation, this will be the estimated amount of forest land not converted to non-forest land as a result of the policy.

- Step 2: Calculate the change in forest carbon stocks from land conversion using equation 7.1 in Section 7.2.4. Set the area term in equation 7.1 equal to the hectares of land from step 1.

  The result of equation 7.1 will be the estimated carbon stock loss that would have occurred if those hectares were deforested. Multiply the result of equation 7.1 by –1 to convert the outcome to carbon stock gain because the policy reduced this amount of forest carbon stock loss. This yields the policy impact on the living biomass carbon pool for the land stratum.

8.6.3 Calculate GHG impacts

Calculate the total policy impact on the living biomass carbon pool by summing the results for all policy scenario strata. Convert the net carbon stock change to GHG emissions reductions or removals, expressed as tonnes of CO_2e, by multiplying by 44/12 and –1. This generates the cumulative policy impact in terms of tonnes of CO_2e emissions (positive) or removals (negative). Divide the cumulative policy impact by the number of years in the assessment period for the annual GHG impacts of the policy.

Where other GHG sources and carbon pools are included in the GHG assessment boundary, calculate their impact in terms of CO_2e emissions and add this to the policy impact on the living biomass carbon pool.

9 Estimating GHG impacts of the policy ex-post

Ex-post impact assessment is a backward-looking assessment of the GHG impacts achieved by a policy to date. The GHG impacts can be assessed during the policy implementation period or in the years after implementation. Ex-post assessment involves evaluating the performance of the policy, and estimating its impact by comparing observed policy scenario values (based on monitored data) with ex-post baseline values. In contrast to ex-ante assessment, which is based on forecasted values, ex-post assessment involves monitored or observed data collected during the policy implementation period. The impact of the policy (ex-post) is estimated by subtracting baseline estimates from policy scenario estimates. Users who are estimating GHG impacts ex-ante only can skip this chapter.

Checklist of key recommendations

- Estimate or update baseline emissions using observed values for parameters that are not affected by the policy and estimated values for parameters that are affected by the policy
- Ascertain whether the inputs, activities and intermediate effects that were expected to occur according to the causal chain actually occurred (if relevant)
- Estimate the GHG impacts of the policy over the assessment period for each GHG source and carbon pool included in the GHG assessment boundary

9.1 Estimate or update baseline emissions

It is a *key recommendation* to estimate or update baseline emissions using observed values for parameters that are not affected by the policy and estimated values for parameters that are affected by the policy. The baseline emissions can be estimated following the method in Section 7.2. Further guidance on monitoring parameters is provided in Chapter 10. The baseline and policy scenarios have the same GHG assessment boundary.

Where the baseline scenario was determined and baseline emissions were estimated in a previous ex-ante impact assessment, this should be updated by replacing estimated values with observed data for non-policy drivers.

FIGURE **9.1**

Overview of steps in the chapter

Estimate or update baseline emissions (Section 9.1) → Estimate GHG impacts (Section 9.2)

Where the results of the assessment will be used to inform GHG accounting and reporting of progress made towards implementation and achievement of NDCs, and meet the reporting requirements of the transparency framework, users should consider aligning the input parameters (e.g. activity data, emission factors, socioeconomic data) used for estimating the GHG impact of forest policies with similar parameters used for GHG accounting and reporting under the Paris Agreement. Some parameters used for the projection of GHG impacts of forest policies can also be used as key parameters for projections developed to meet reporting requirements of the transparency framework.

9.2 Estimate GHG impacts

9.2.1 Evaluate performance of the policy (if relevant)

The performance of the policy should be evaluated to ensure that the GHG impacts calculated ex-post can be attributed to the policy. To do this, it is a *key recommendation* to ascertain whether the inputs, activities and intermediate effects that were expected to occur according to the causal chain actually occurred. This step can be skipped for ex-post impact assessments where no previous ex-ante assessment has been conducted.

Chapter 10 provides examples of the inputs and activities that should be monitored to evaluate the performance of the policy. If users cannot ascertain that the inputs or activities occurred, it is not possible to attribute GHG impacts to policy implementation.

Users should also examine whether the intermediate effects in the causal chain occurred. It may not be feasible to monitor all intermediate effects. At a minimum, each of the intermediate effects linked to GHG sources and carbon pools included in the GHG assessment boundary should be monitored with at least one parameter. Tables 6.2 and 6.3 in Chapter 6 provide examples of intermediate effects that should be monitored. If users cannot confirm that these intermediate effects occurred, it is not possible to attribute GHG impacts to policy implementation.

Note that inputs, activities and/or intermediate effects may be smaller or larger than expected, but this does not mean that GHG impacts cannot be attributed to the policy.

9.2.2 Estimate the GHG impacts of the policy

It is a *key recommendation* to estimate the GHG impacts of the policy over the assessment period for each GHG source and carbon pool included in the GHG assessment boundary. The same methods used to estimate baseline emissions should be used to estimate policy scenario emissions to allow meaningful tracking of performance over time.

Users should calculate policy scenario emissions using the estimation methods in Section 7.2. Observed, measured or recently collected activity data, and measured or re-estimated emission factors should be used. Further guidance on monitoring parameters is provided in Chapter 10.

If using the emissions approach, the GHG impacts of the policy are calculated by subtracting baseline emissions (estimated in Section 9.1) from the ex-post policy scenario emissions for each GHG source and carbon pool included in the GHG assessment boundary.

If using the activity data approach, the GHG impact of the policy is calculated directly, by determining the actual implementation level using observed, measured or recently collected data, and measured or re-estimated emission factors. It is not necessary to estimate the GHG emissions of the baseline scenario when using this approach. Rather, users should follow the method in Section 8.6.2 using ex-post activity data and emission factors. Under this approach, users should carefully consider the policy's inputs and activities, and intermediate effects that occurred ex-post as a result of the policy. Users should report and justify that the actual implementation level (e.g. the observed change in activity data) is the result of the policy.