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TOWARDS DEVELOPMENT/ STRENGTHENING OF THE NATIONAL GHG INVENTORY SYSTEM —

CONCEPTUAL FRAMEWORK FOR MONITORING, REPORTING AND VERIFICATION OF LAND USE, LAND-USE CHANGE AND FORESTRY (LULUCF) SECTOR IN GEORGIA

MRV LULUCF GEORGIA

DETAILED REPORT

EU4Climate
Better Climate Policies for Eastern Partner Countries

November 2022

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DETAILED REPORT

DETAILED REPORT ON LULUCF MRV SYSTEM INSTITUTIONAL AND METHODOLOGICAL ARRANGEMENT COMPONENTS

November 2022

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Outline

INTRODUCTION

This report aims to propose organizational options for carrying out LULUCF sector of the national GHG inventory. These options are thought based on the elements received during the project, the assessment carried out in the first part of the project and the interviews conducted with the national actors whose role could be relevant for the implementation of a LULUCF inventory.

The report presents the following chapters:

1. Proposed options for LULUCF inventory system
2. Proposed procedures to ensure that organizations and individuals will participate and collaborate
3. Proposed workplan for LULUCF inventory
4. Simplified guidelines and information for national experts to process LULUCF inventory

1. PROPOSED OPTIONS FOR LULUCF INVENTORY SYSTEM

1.1. GENERAL PICTURE FOR A LULUCF INVENTORY SYSTEM

In the options presented below, a general picture was designed to fully understand the different organization options (cf. Figure 1). In this picture, voluntarily, no arrow has been added to specify the roles because when arrows are added it often becomes too complex.

Four major responsibilities are identified:

- Political responsibility of GHG Inventory
- Technical responsibility of GHG Inventory compilation and coordination
- Technical responsibility of LULUCF GHG Inventory implementation
- Technical responsibility of data provision for LULUCF GHG Inventory

The political responsibility and the technical responsibility of the GHG inventory covers a wider scope than the LULUCF inventory alone. As it seems that the general structure seams quite clear in Georgia, the options detailed below do not vary regarding the general organization:

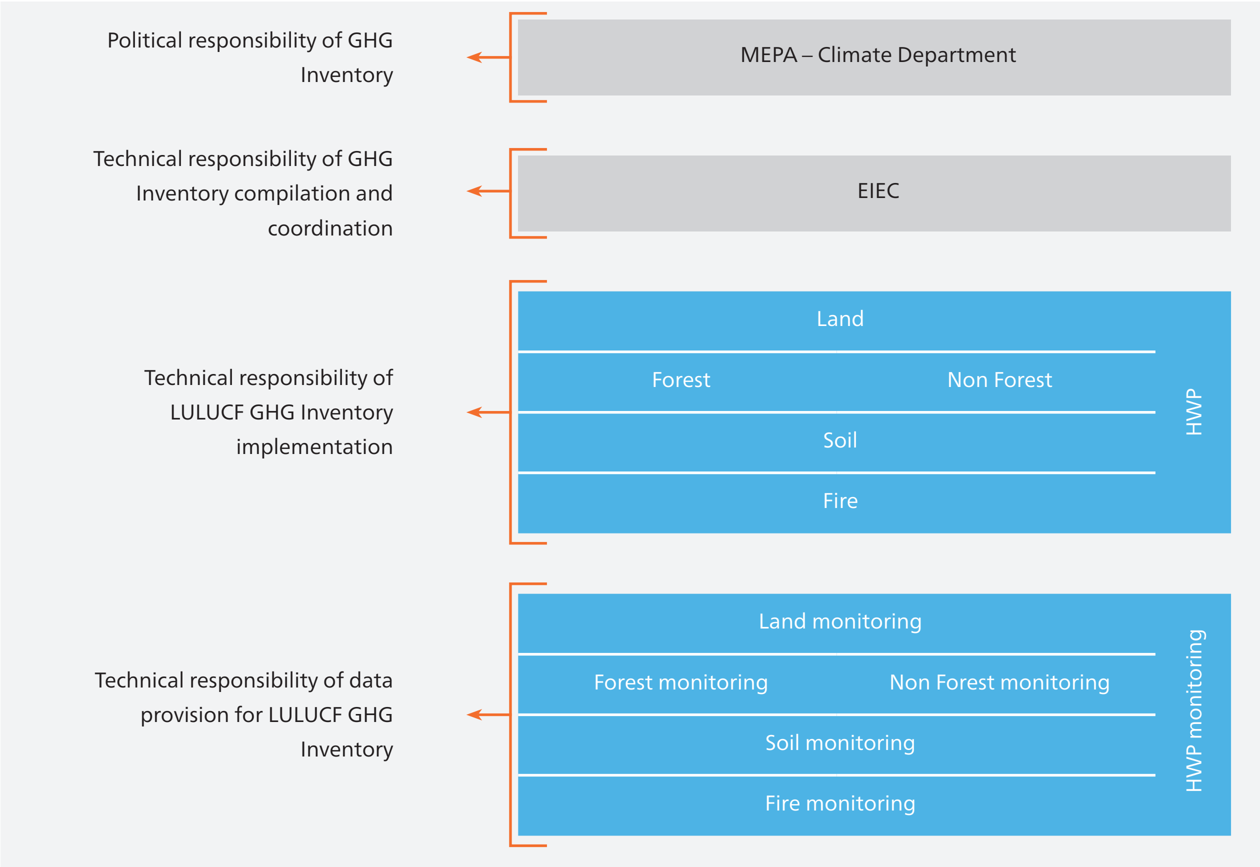
- Political responsibility of GHG Inventory = MEPA's climate division
- Technical responsibility of GHG Inventory compilation and coordination = The EIEC is entrusted by the MEPA with the technical realization of the inventory
- Technical responsibility of LULUCF GHG Inventory implementation = several options are proposed in this report
- Technical responsibility of data provision for LULUCF GHG Inventory = 1 picture is presented in this report, it cannot show all effective contributions in terms of data provision, only major data providers are explicitly mentioned but it does not mean that others do not exist.

In this study, the LULUCF sector is presented as 6 independent bricks, that can be considered from inventory compiler or from data provider point of view:

- Land (estimates of land-use and land-use change area)
- Forest (estimates of emissions and removals for biomass and dead organic matter in forest land and land converted to forest)
- Non-forest (estimates of emissions and removals for biomass and dead organic matter in all other land categories)
- Soil (estimates of emissions and removals for soils)
- Fire (estimates of emissions due to wildfires)
- HWP (estimation of carbon stock change within harvested wood products).

Variations may be specified on each brick of the LULUCF sector.

FIGURE 1: GENERAL SCHEME FOR A LULUCF INVENTORY



1.2. EXPERTISE AND RESOURCES FOR EACH ENTITY OF THE SYSTEM

The different options will be based on expected skills, resources, and tools for each brick of the LULUCF system.

1.2.1. Political responsibility for entire inventory

The political responsibility requires a solid institutional anchoring. It is most often carried by a ministry or an inter-ministerial body. The main requirement is the legitimacy of the institution at national level. This political mandate can be strengthened by an independent committee including representatives from different horizons.

In Georgia, the climate division of the Ministry of Environmental Protection and Agriculture (MEPA) has currently the political responsibility for GHG inventories. The Climate Change Council (CCC) may or could act as a steering committee for the national inventory.

The project aims to analyze the LULUCF system, without focusing on the more global system of the GHG inventory that appears quite clear. There is no reason to change this organization.

1.2.2. Technical responsibility for entire inventory

Technical coordination of the inventory is essential. It can cover the logistical organization with the recruitment of experts for example or the elaboration of working agreements and the work of verification of inventories produced.

Coordination should ensure:

- verification of the estimates made by sectoral experts,
- the proofreading of the reports by the sectoral experts,
- the analysis in key categories,
- the analysis of uncertainties,
- the follow-up of the improvement plan,
- the follow-up with internal and external reviews,
- the follow-up of compliance with deadlines,
- the follow-up of international requirements.

The technical responsibility for the inventory is entrusted to the Environmental Information and Education Centre (EIEC) by the MEPA. This was already the case in previous inventory exercises, but the scope of the EIEC has recently increased with the new responsibility[1] given to EIEC for producing the biennial transparency report (BTR).

The project aims to analyze the LULUCF system, without focusing on the political responsibility of the global system of the GHG inventory. The political responsibility seems rather clear, there is no reason to change this organization.

1.2.3. Technical responsibility for LULUCF inventory

As presented above, the implementation of a LULUCF inventory can be carried out with a division of tasks according to the topics. Each topic requires different technical and scientific skills that can be difficult to find in a single team. Nevertheless, it must be noted that the multiplication of actors has many negative effects: it requires much more human resources and can generate problems of consistency.

1.2.3.1. LAND

Land monitoring is the backbone for a good LULUCF inventory. Nowadays, almost all the inventories are betting on satellite imagery. This makes sense as the accuracy can be very good and is rather cheap compared to a „traditional" tracking system.

It should also be reminded that there are many ways to process satellite information and these tasks are complex. Most often, satellite image processing activities are not directly related to inventory activity for LULUCF sectors but are the result of dedicated programs.

1 Information provided by interviews from Ms. Maia Tskhvaradze (MEPA) and Ms.Tamar Aladashvili (EIEC)

In the current inventories of Georgia, land monitoring is done by assembling a lot of data, but the result is partial, some land use changes are not covered.

A few requirements on land monitoring are presented below:

- Consistency of the time series of land monitoring.
- Consistency with the sources of information deemed reliable (e.g. forest area)
- Estimates of land use changes between major land categories.
- Estimates of change matrices with annual time step and 20 year time step.

To ensure the correct incorporation of cartographic products and other data on land monitoring, it is useful to have solid knowledge in information systems, but also to know the specific requirements of the IPCC in terms of definition. IPCC guidelines (mostly IPCC 2006, and as far as possible IPCC 2013 supplement and IPCC 2019 refinement) must be mastered.

For example, the IPCC makes the distinction between land-use and land-cover. IPCC considers land-uses. Therefore, a land without trees can be classified as a forest under the IPCC. On the contrary, maps (from satellite data or photo interpretation…) often considers land covers, and therefore do not classify areas without trees as forests.

The resources required to process land use data are more important when the products are numerous and heterogeneous.

The effort is dependent on the size of the territory but not proportional to the area covered. The installation of an efficient land use monitoring may take months of work even when rough data is available.

TABLE 1: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON LAND

Resources	Estimates for Georgia
Human resources	1-3 people (2-6 months per year in routine, much more for development)
Technical skills	GIS, geography, data treatment, IT, IPCC guidelines
Tools	GIS software (QGIS…), database software (PostgreSQL…), data treatment software (Excel)…

1.2.3.2. FOREST

Forest is a key element in a LULUCF, because forest are often large carbon stocks in biomass and soils.

The work to carry out the forest part of the LULUCF inventory may be closely related to the production of forest data but not necessarily. Indeed, forest data normally aimed at monitoring the volumes of markeTable and exploiTable wood while the LULUCF inventory covers the total biomass of trees. One of the crucial points is also to succeed in distinguishing forest land from non-forest land that can also have trees and similar logging operations. The temporal expected resolution for LULUCF is annual which is rarely the case for forest inventory. The split between forest management and deforestation is essential which is rarely the case for forest inventory.

It is therefore a work specific to the LULUCF inventory that must be carried out for the forest part which should not be confused with the forest inventory work.

Main challenges for forest responsibility:

- Filter data regarding their value for LULUCF inventories
- Master the IPCC guidelines
- Convert existing forest data into carbon gains from forest growth for total living biomass
- Convert existing forest data into carbon losses due to harvests or mortality for total living biomass
- Manage dead organic matter pools (litter and dead wood), soil organic matter may be covered apart
- Reconcile harvest and wood consumption data across the territory
- Compile specific factors for the forests of the territory, for instance wood densities
- Know the existing forest inventories
- Ensure consistency with the non-forest parts of the LULUCF inventory.

TABLE 2: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON FOREST

Resources	Estimates for Georgia
Human resources	1-2 people (1-5 months per year in routine)
Technical skills	Scientific engineer, forest background, IPCC guidelines
Tools	data treatment software (Excel), database software (SQL…)

1.2.3.3. NON-FOREST

This is one of the organizational difficulties of this sector, the LULUCF does not only deal with forests. A large part of the sector concerns agricultural land, but also urbanized land, wetlands...

It is possible to have the treatment of these lands carried out by a generalist structure or a structure that also manages forestry issues. But, in the case of significant split of the work, it is relevant to entrust this activity to a structure with agricultural missions.

Indeed, most of the non-forest land with carbon is agricultural land.

It should also be noted that in countries where wetlands are important, these lands can justify significant work because of the large carbon stocks presents in soils and the possible greenhouse gas emissions. However, it does not seem essential to involve structures whose main mission would be the monitoring of these wetlands in the LULUCF inventory.

Main challenges for non-forest responsibility:

- Master the IPCC guidelines
- Work in collaboration with the structure in charge of monitoring the land (when different)
- Cover all non-forest carbon fluxes from major carbon pools (soil organic matter may be treated separately)
- Use agricultural statistical data to estimate biomass gains and losses, especially for perennial crops
- Ensure consistency with the agriculture sector of the GHG inventory
- Ensure consistency with the forest part of the LULUCF inventory.

TABLE 3: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON NON-FOREST

Resources	Estimates for Georgia
Human resources	1 people (1-2 months per year in routine)
Technical skills	Scientific engineer, agriculture or generalist background, IPCC guidelines
Tools	data treatment software (Excel), database software (SQL…)

1.2.3.4. SOIL

Soils can be an important part of greenhouse gas inventories because they are significant carbon stocks, particularly in forests and agriculture. They can be processed by a dedicated structure that would have sharp skills on soils.

In agriculture, soil is essential because it constitutes both very large carbon stocks but also the working tool of farmers. Soil fertility is indeed a major criterion for the economic health of farms. However, this fertility is linked to the organic matter of the soil and therefore to carbon. This is a sensitive but rather consensual topic: it is necessary to preserve the organic matter of the soil or to restore it. It removes carbon from the atmosphere and keep agricultural soils healthy.

Be careful, however, not to mix soil and land in the sense of the IPCC, soil science is not at all the most appropriate skill to monitor land. The interest of involving a specific structure expert in soils seem relevant only when complex models on soils are used in the LULUCF inventory. For basic treatment of soils generalist or agricultural experts are much more indicated.

Main challenges for non-forest responsibility:

- Master the IPCC guidelines
- Mobilize soil carbon evolution models
- Link to land use change
- Know the evolution of agricultural and forestry practices impacting soil carbon stocks
- Mobilize statistical resources to feed models
- Have knowledge of soil characteristics.

It should also be remembered that difficulties depend on the level of ambition of the inventory. There is no quality standard for an inventory. For example, it is not imperative to do a complex modeling of soil carbon to have a good LULUCF inventory. On the other hand, the soil part of the inventory must be managed in a consistent way, weighted according to the real impacts in terms of carbon.

TABLE 4: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON SOIL

Resources	Estimates for Georgia
Human resources	0-2 people (0-5 months per year in routine) (depending on the complexity)
Technical skills	Scientific engineer, agriculture or soil background, IPCC guidelines, modelling (if models)
Tools	IT development (Python, R…) (if models), data treatment software (Excel), database software (SQL…)

1.2.3.5. FIRE

Fires can affect all types of land and are often followed by a different structure than the traditional statistical system. For the LULUCF inventory, it is important to correctly account for the fires, but it does not seem very relevant to have a structure dedicated to the calculations of fire emissions for the LULUCF inventory. Of course, it depends on the overall organization.

Usually, fire emissions can be estimated by a generalist manager also in charge of the forest or non-forest part.

Main challenges for fire responsibility:

- Master the IPCC guidelines
- Compile data on burned surfaces
- Intersect this information with vegetation data
- Ensure consistency with the forest and non-forest parts of the inventory

TABLE 5: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON FIRE

Resources	Estimates for Georgia
Human resources	0-1 people (a few days per year in routine)
Technical skills	Scientific engineer, agriculture or forest background, IPCC guidelines,
Tools	data treatment software (Excel), GIS (if complex)

1.2.3.6. HWP

The harvested wood product (HWP) sector is linked to the LULUCF sector because it works the same way and is often linked to the forestry sector, which produces wood. It remains that the result on wood products concerns wood once harvested but the use of wood is therefore not closely related to the land of production.

To make a good inventory of the wood product sector, it is necessary to have accurate statistics on the activity of sawmills and on exchanges (imports / exports of wood). Then, to better estimate the lifetime of wood products, dedicated studies are necessary. Otherwise, IPCC methods are available with lifetime default factors.

Main challenges for HWP responsibility:

- Master the IPCC guidelines
- Process data on wood processing activity in the country
- Process data on wood harvests
- Process wood trade data (import/export)
- Know the wood processing activity

Usually, HWP emissions/removals can be estimated by a generalist manager, but it is relevant to have specific knowledge in wood production or forest stakeholders for this specific work.

TABLE 6: EXPECTED RESOURCES FOR THE TECHNICAL RESPONSIBILITY ON HWP

Resources	Estimates for Georgia
Human resources	0-1 people (a few days per year in routine)
Technical skills	Scientific engineer, forest background, IPCC guidelines
Tools	data treatment software (Excel), IPCC tool on HWP

1.2.4. Technical responsibility for data provision

The responsibility for data provision should be included in the system. The technical work for inventory production cannot be efficient without any data provision. Yet it must be reminded a few generic but important elements:

- there are several ways to implement a correct inventory for LULUCF and it cannot be expected very specific data on all topics. For instance, inventories require data for the past that cannot be collected anymore. The resolution of the inventory can be very different from a country to another…
- Usually, the LULUCF inventory is adapted to the data provision structure, not the contrary. But, for some categories, data provision can evolve to better respond to LULUCF expectations.
- Some of the possible changes concern the questionnaires that are used for survey. They can integrate new questions, keeping it mind that questions must be cautiously built to be useful for a LULUCF inventory. Experts in statistics are always needed to modify efficiently questionnaires.
- The data collection is an expensive activity (compared to inventory production), it requires much more budget because of the work of preparation, surveyors, data treatment, etc. LULUCF inventory cannot be the only purpose of a statistical activity. In practice LULUCF inventory exist in many countries, because it is based on existing statistical data.

In the following paragraphs, the skills, resources, and tools needed for each data provision won't be detailed, because it is too difficult to assess. Data collection is based on a large panel of actors and on developments that are often existing for years.

The main objective of this work is to identify the structures involved in the data collection useful for LULUCF inventories. There may be some overlaps or gaps for data collections that can be clarified in the LULUCF system, but global missions for structures should not be changed according to new data collection purposes.

TABLE 2: POSSIBLE DATASET FOR LAND-USE MONITORING

theme	Typical datasets or assumptions needed	
Land	• Land use map, land cover map, land cover change map • Land use change statistics	• Annual area of IPCC land use category • Annual area of land use change for all conversions and from 1990
Forest	• Forest carbon stocks • Increment – annual values • Mortality losses – annual values • Harvest losses (direct losses and indirect losses)	• Litter carbon stocks • Deadwood carbon stocks • Litter and deadwood carbon stock variation • Commercial and illegal loggings • Expansion factors
Non-forest	• Annual crop biomass stocks • Grassy grassland biomass stocks • Woody grassland biomass stocks	• Perennial crops biomass stocks • Perennial crops biomass increment • Annual crop yields

Soils	• Stocks per climate zone and per land use category • Organic soil area	
Fires	• Annual areas of fires	• Fraction of burnt biomass
HWP	• Commercial wood statistics	• Imported and exported wood

1.2.4.1. LAND MONITORING

The expectation in terms of land monitoring is the availability of products (maps, statistics) on land use and land use changes for long times series. Ideally since 1970, but hopefully since 2000.

It may be produced by different data producers but ideally it is made by a unique producer for all land uses.

Land monitoring data may require a lot of resources to deal with satellite imagery for instance. But in fact this monitoring may be much cheaper than any other survey only based field measurement. Classical skills for such data producer are IT skills for imagery treatments. It is time consuming but often already in preparation or prepared in many countries, there is a lot of pressure to use satellite imagery and a lot of expectations.

The distribution of work between the inventory team and the data producer must be adjusted according to skills and the missions of the data producer.

TABLE 3: TYPICAL DATA NEEDS

Dataset	Data provider	Potential issues
Land balance	Land agency	• compatibility with IPCC land-use categories • mixed areas issues • Lack of consistency with NFI ?
NFI – pre-classification of all country sampling points	NFA	• Not enough details for land use categories • Need of reclassification of past years
ESA CCI LC	ESA	• No data for past years • Lack of consistency with NFI
CLC	Copernicus & specific project	• Only pilot project • No data for past years • Lack of consistency with NFI
Other land cover map	Specific national or international project	• Temporal and spatial resolution • Lack of consistency with NFI

Other statistic dataset	Specific national or international dataset	- Not spatially explicit - Lack of consistency with NFI
Mix of data – integration model	Several + Expert	- Lack of expertise, lack of resources - High complexity

1.2.4.2. FOREST MONITORING

Forest monitoring mostly means forest inventory. It exists for a long time in many developed countries, but it is absent in most developing countries. The forest inventory is often the main objective of forest agencies, it cannot be easily replaced by a simplified data collection. Additional data can be also collected through land management plans, but it remains more challenging to produce a homogenous monitoring of the entire territory.

In Georgia, the data collection for the first real forest inventory is ongoing. Data are not available yet.

Expected data from a forest inventory may be:

- Increment (volumes of commercial wood or tonnage of total biomass)
- Stocks of trees (volumes of commercial wood or tonnage of total biomass)
- Harvest (volumes of commercial wood or tonnage of total biomass)
- Mortality (volumes of commercial wood or tonnage of total biomass)
- Stock of dead wood (volumes or tonnage)
- Stock of litter (volumes or tonnage)

The forest inventory usually gives a lot of information that are not always very useful for LULUCF inventory but depending on the ambition a lot of additional detail can be used for modelling more accurately emissions and removals.

The resources for such forest inventory are high, because it requires a lot of time from foresters. It is usually expected for long periods (like every 10 years in Georgia). In practice, very abrupt changes can occur in forest due to special events like windfalls, droughts, fires… But few countries have the capacity to produce annual results from forest inventories.

In countries where only one forest inventory is available, dynamics cannot be easily estimated and this one of the major differences between LULUCF and other sectors: in most cases annual information on current situation is not enough. Temporal information is required.

Other forest data can be considered in statistics like volume of harvest, areas of plantations, wood consumptions… the list of possible data provision is not fixed, if many sources are used it is necessary to be very cautious to avoid gaps and overlaps.

1.2.4.3. NON-FOREST MONITORING

This section brings together a wide range of statistical data but in fact mainly data relating to agricultural land. The classic data of agricultural statistics (areas, yields, productions) can be mobilized for LULUCF inventories. These data provision requires a lot of resources but are usual already in place in countries.

Data on agroforestry systems, orchards, hedgerows can also be useful for the LULUCF inventory. The statistics usually present areas for each crop cultivation but may be limited for mixed crops like agroforestry systems and of course with hedgerows which are very rarely covered.

It is most often for estimates of soil emissions and removals that agricultural statistics are used. Indeed, soil carbon variations are most often estimated from changes in land use and land practices. For soils, statistics on agricultural practices will be more useful than data specifically on soils. The statistics mentioned to evaluate the soils remain quite difficult to produce, they concern tillage, the levels of organic and inorganic inputs, the presence of intermediate crops, the use of crop residues, the rotation of crops ...

On wetlands, including peat extraction zones, data on areas, productions, type of extraction are required for LULUCF inventories.

On urban and other land, few estimates are expected but sometimes there may be estimates related to urban trees or non-agricultural fertilization. Low efforts are assumed on these areas.

1.2.4.4. SOIL MONITORING

A key message of inventories is that estimating carbon stocks in soils is not a real objective, it is the variation of these carbon stocks that is targeted. Soil science is an expertise that is not easily mobilized in LULUCF inventories. Most of the expectations correspond to the realization of a pedoclimatic map allowing the use of IPCC references. This map, if it exists, is useful for adjusting carbon flux calculations but it is not a statistic. It does not offer the dynamic elements necessary for a LULUCF inventory.

In rare cases, territory-specific data can be used to refine soil carbon dynamics. Dynamic soil carbon monitoring systems are very rarely put in place.

Specific soil surveys are sometimes used in inventories, they cannot be considered as key for the inventory system.

On soils, one of the main ways is modelling and therefore the use of soil models. But large-scale modelling is mainly based on agricultural data. Climate data can also be considered, but these complex models are not possible in the short term for the GHG inventory in Georgia. It must be carried by the entities in charge of the inventory.

1.2.4.5. FIRE MONITORING

Data on areas burnt are required for the LULUCF inventory. Usually, this data exists, they are collected by a structure in charge of civil protection.

1.2.4.6. HWP MONITORING

Data on wood products may exist in national statistics, or not. It can be obtained by surveys on sawmills for instance.

For the LULUCF inventory it would be necessary to know the quantity of wood products for at least the following categories of wood:

- Long-lived wood (wood frames, panels)
- Short-lived wood (packaging)
- Paper
- Wood energy

One of the major difficulties is that wood is exchanged a lot between countries as logs or finished products, which makes the monitoring difficult.

For current inventories the rule is (in theory) to follow of all wood products made from trees which have grown in the territory. Imported timber is not included in the country reporting.

Wood products may be made from different origins but usually it comes mostly from forests, this statistic may be linked to forest statistics.

1.3. POSSIBLE OPTIONS FOR A LULUCF INVENTORY SYSTEM

Technical responsibility of LULUCF inventory:

Many options are possible for a LULUCF system, in particular for the technical responsibility of LULUCF inventory. Basically 2 extreme options may exist (with a lot of possible intermediate options):

- 1 structure in charge of all bricks of a LULUCF inventory
- 1 structure per brick of the LULUCF inventory

The technical responsibility for LULUCF inventory is modulated depending on the strategy of the country. For instance, it is strongly recommended to avoid the multiplication of actors for the technical responsibility of LULUCF as far as needed resources would be very high and consistency difficult to ensure. There is an implicit leadership when 2 organizations are involved. The leadership comes to the entity in charge of land, because this is the basis for a good LULUCF inventory.

Options with more than 2 organizations involved in technical responsibility for LULUCF were analyzed but finally not kept. Coordination of work becomes very challenging when several organizations are involved.

It is important to note that the land agency that was initially proposed as technical inventory compiler for some options is finally not proposed anymore as far as they explicitly consider theme selves as data providers only.

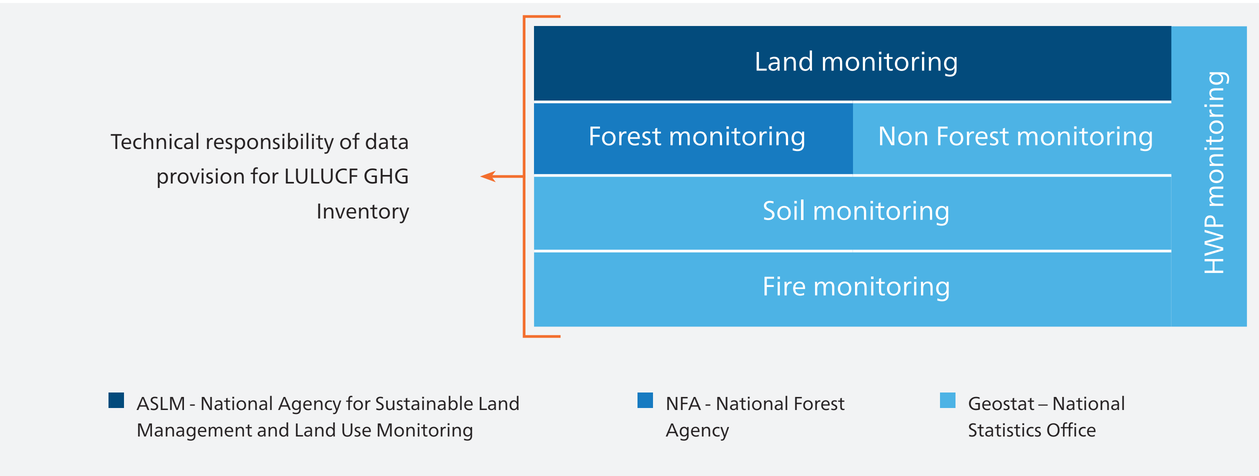
It also appeared that there is no organization that is naturally involved in the non-forest issues for the LULUCF GHG inventory. For forest, both the National Forest Division of MEPA and the National Forest Agency look very interested in GHG inventory issues. For non-forest issues it was not possible to really find an organization that could be involved. The SCRA (Agricultural Scientific - Research Center) and the SLA (State laboratory of agriculture) were contacted but without feedback during the project time frame. They were not kept as potential stakeholders.

Technical responsibility for data provision

It is assumed that the technical responsibility for data provision is much linked to existing structures. It is not modulated according to the options.

The responsibility currently identified in terms of data provision may be:

FIGURE 4: DISTRIBUTION OF RESPONSIBILITIES FOR DATA PROVISION



This simplified representation of data providers may mask the contribution of different stakeholders. But, the data provision is not the main object for this specific project mostly focusing the technical responsibility for LULUCF inventory.

The following options are examples of what the system could look like. They don't present a definitive picture of possible systems, and in many cases, all structures could be replaced by another which would finally be considered as more appropriate.

1.3.1. Option 1(a)

The option 1(a) gives the entire responsibility of LULUCF inventory to the forest division of MEPA. It implies that:

- The LULUCF inventory is made internally by a division of MEPA
- The LULUCF inventory is made by one team
- The LULUCF inventory is made by a structure that encompass its usual scope of work

FIGURE 5: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 1(A)

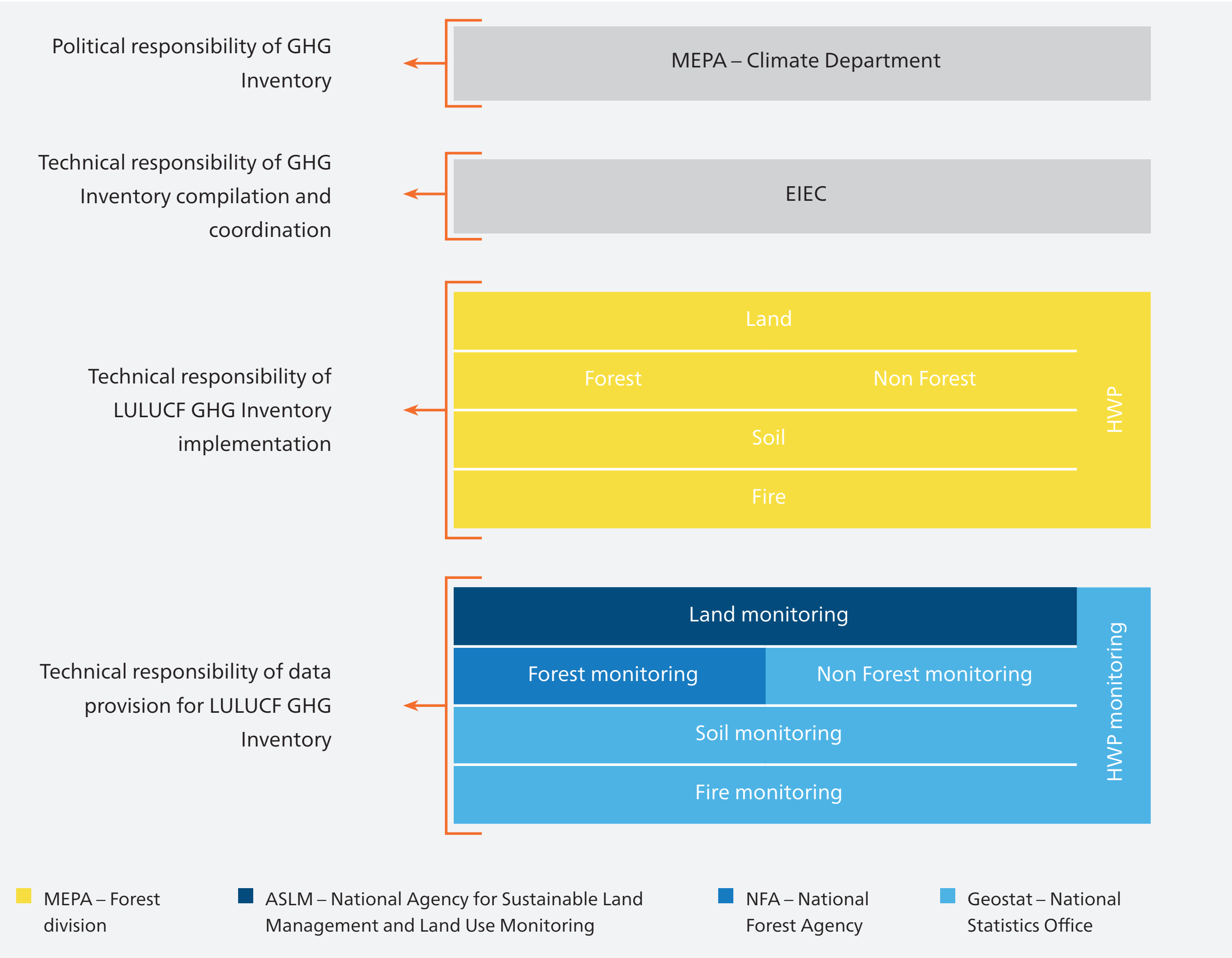


TABLE 7: STRENGTHS AND WEAKNESSES OF OPTION 1(A)

Strengths	Weaknesses
• High guarantee of consistency among subcategories of LULUCF • High involvement of the team (responsibility is not scattered) • Good linkage with the rest of the GHG inventory • Good connection with forest data providers • Good expertise in forest issues • Saving of resources	• Possible low involvement in non-forest issues • Possible conflict with other structures which were legitimately interested in this task • Possible lower expertise in land monitoring and lower focus on land use changes • Possible lower expertise in agriculture issues • Possible difficulty to dedicate human resources from MEPA (if managed as a project)

1.3.2. Option 1(b)

The option 1(b) gives the main responsibility of the LULUCF inventory to the forest division of MEPA. Yet the agriculture division of MEPA oversees non-forest issues. It implies that:

- The LULUCF inventory is made internally by MEPA.
- The leadership is given to the forest division (the land responsibility gives the leadership)
- The LULUCF inventory is made by 2 structures that fits quite well their usual scope

FIGURE 6: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 1(B)

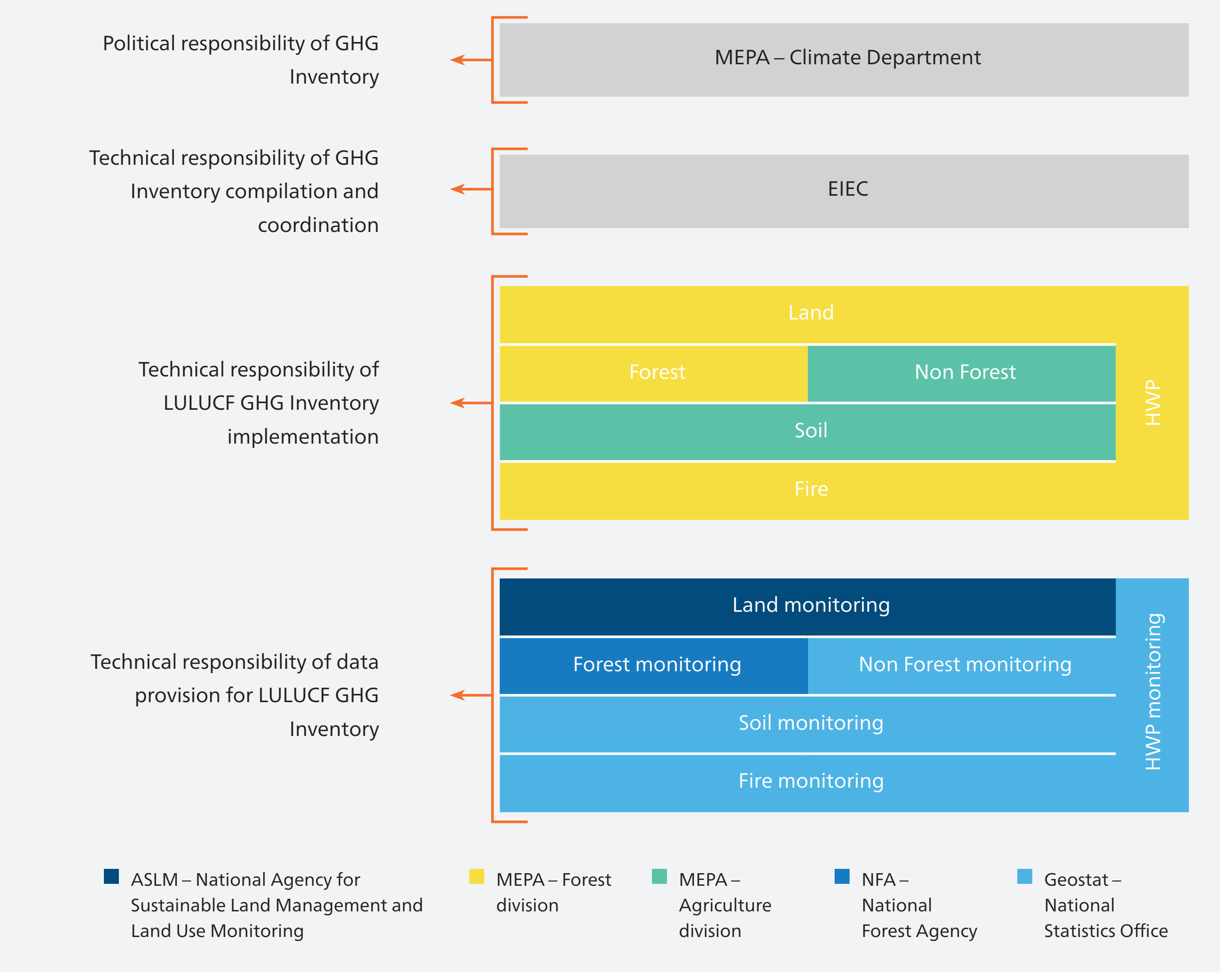


TABLE 8: STRENGTHS AND WEAKNESSES OF OPTION 1(B)

Strengths	Weaknesses
• Good guarantee of consistency among subcategories of LULUCF • Good linkage with the rest of the GHG inventory • Good connection with forest data providers • Good connection with agriculture data providers • Good expertise in forest issues • Importance given to soil management in agriculture	• Possible concurrency in the leadership • Possible low involvement of agriculture division (No clue on possible involvement from agriculture division) • Possible gaps in consistency between subcategories • Possible lower expertise in land monitoring and lower focus on land use changes • Possible difficulty to dedicate human resources from MEPA (if managed as a project)

1.3.3. Option 2(a)

The option 2(a) gives the entire responsibility of LULUCF inventory to the agriculture division of MEPA. It implies that:

- The LULUCF inventory is made internally by a division of MEPA
- The LULUCF inventory is made by one team
- The LULUCF inventory is made by a structure that encompass its usual scope of work

FIGURE 7: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 2(A)

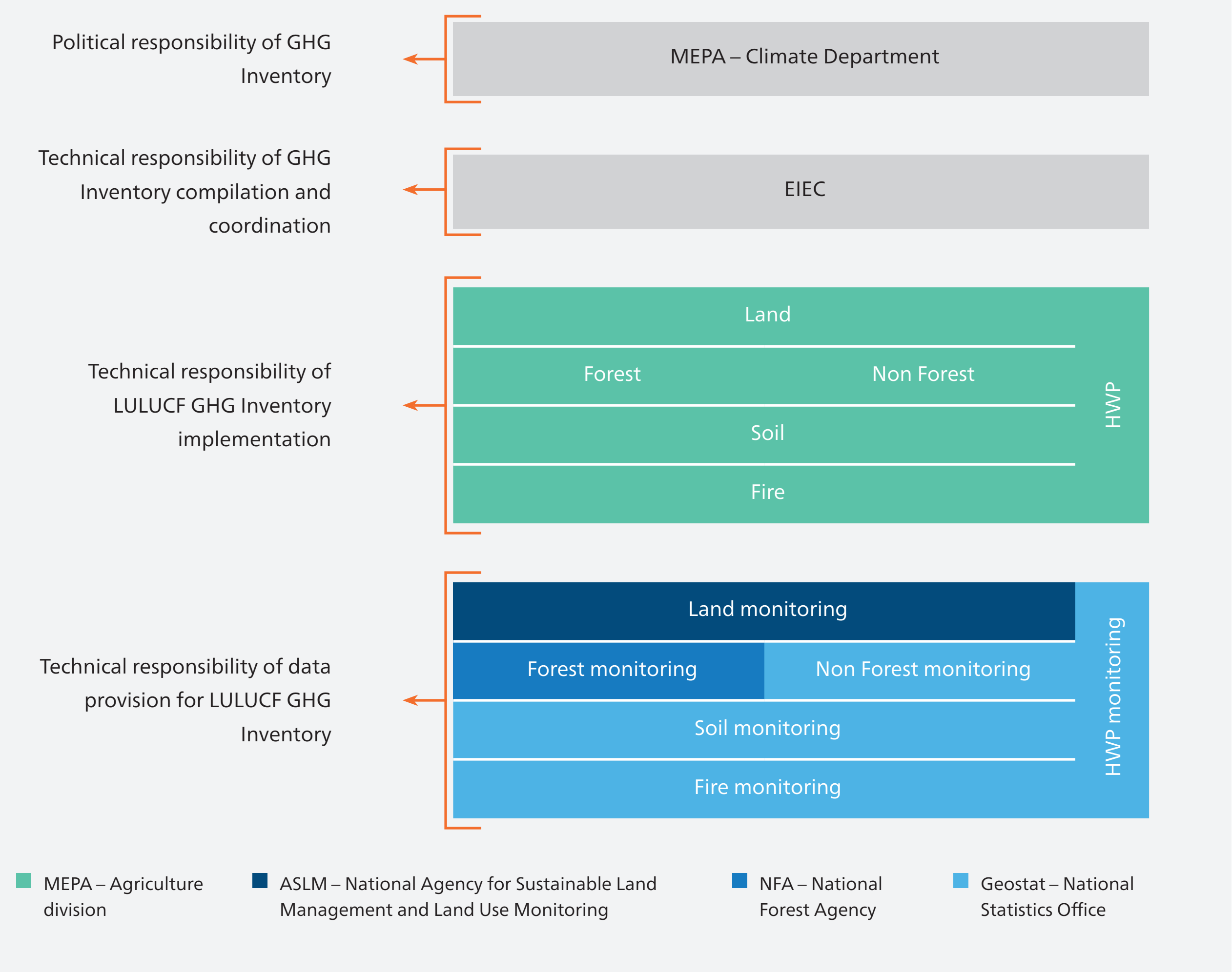


TABLE 9 : STRENGTHS AND WEAKNESSES OF OPTION 2(A)

Strengths	Weaknesses
• High guarantee of consistency among subcategories of LULUCF • High involvement of the team (responsibility is not scattered) • Good linkage with the rest of the GHG inventory • Saving of resources	• Possible low involvement in forest issues • Possible conflict with other structures which were legitimately interested in this task • Possible lower expertise in land monitoring and lower focus on land use changes • Possible lower expertise in forest issues • Possible difficulty to dedicate human resources from MEPA (if managed as a project)

1.3.4. Option 2(b)

The option 2(b) gives the main responsibility of the LULUCF inventory to the agriculture division of MEPA. The forest division of MEPA oversees forest issues. It implies that:

- The LULUCF inventory is made internally by MEPA.
- The leadership is given to the agriculture division (the land responsibility gives the leadership)
- The LULUCF inventory is made by 2 structures that fits quite well their usual scope

FIGURE 8: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 2(B)

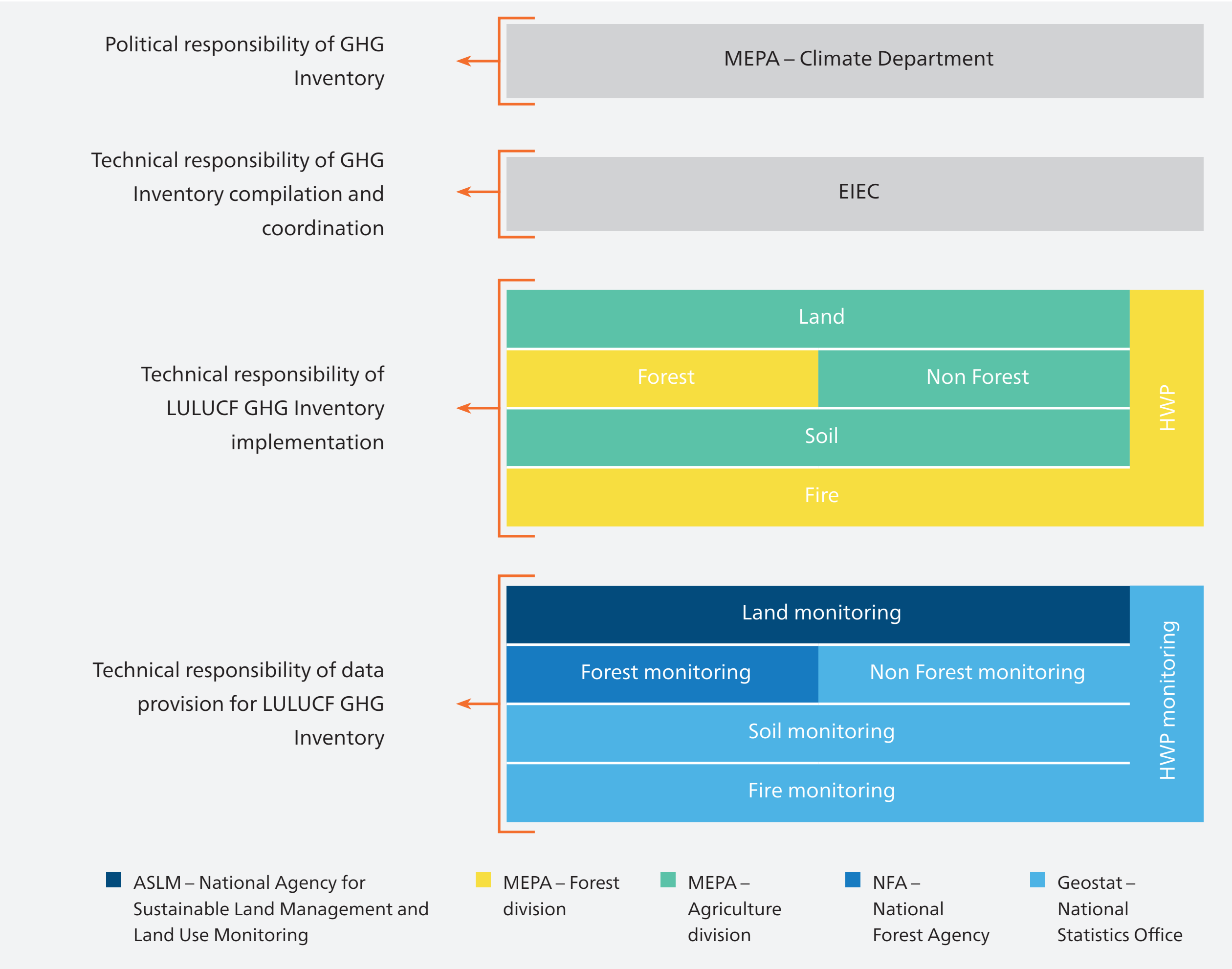


TABLE 10: STRENGTHS AND WEAKNESSES OF OPTION 2(B)

Strengths	Weaknesses
• Good guarantee of consistency among subcategories of LULUCF • Good linkage with the rest of the GHG inventory • Good connection with agriculture data providers • Good connection with forest data providers • Importance given to soil management in agriculture	• Possible concurrency in the leadership • No guarantee on agriculture's division of MEPA (No clue on possible involvement from agriculture division) • Possible low involvement of forest division • Possible lower expertise in land monitoring and lower focus on land use changes • Possible difficulty to dedicate human resources from MEPA (if managed as a project)

1.3.5. Option 3(a)

The option 3(a) gives the responsibility of the LULUCF inventory to Geostat, the National Statistics Office. It implies that:

- The LULUCF inventory is made externally by an agency partially dependent of MEPA.
- The LULUCF inventory is made by 1 structure that have high connection with data.

FIGURE 9: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 3(A)

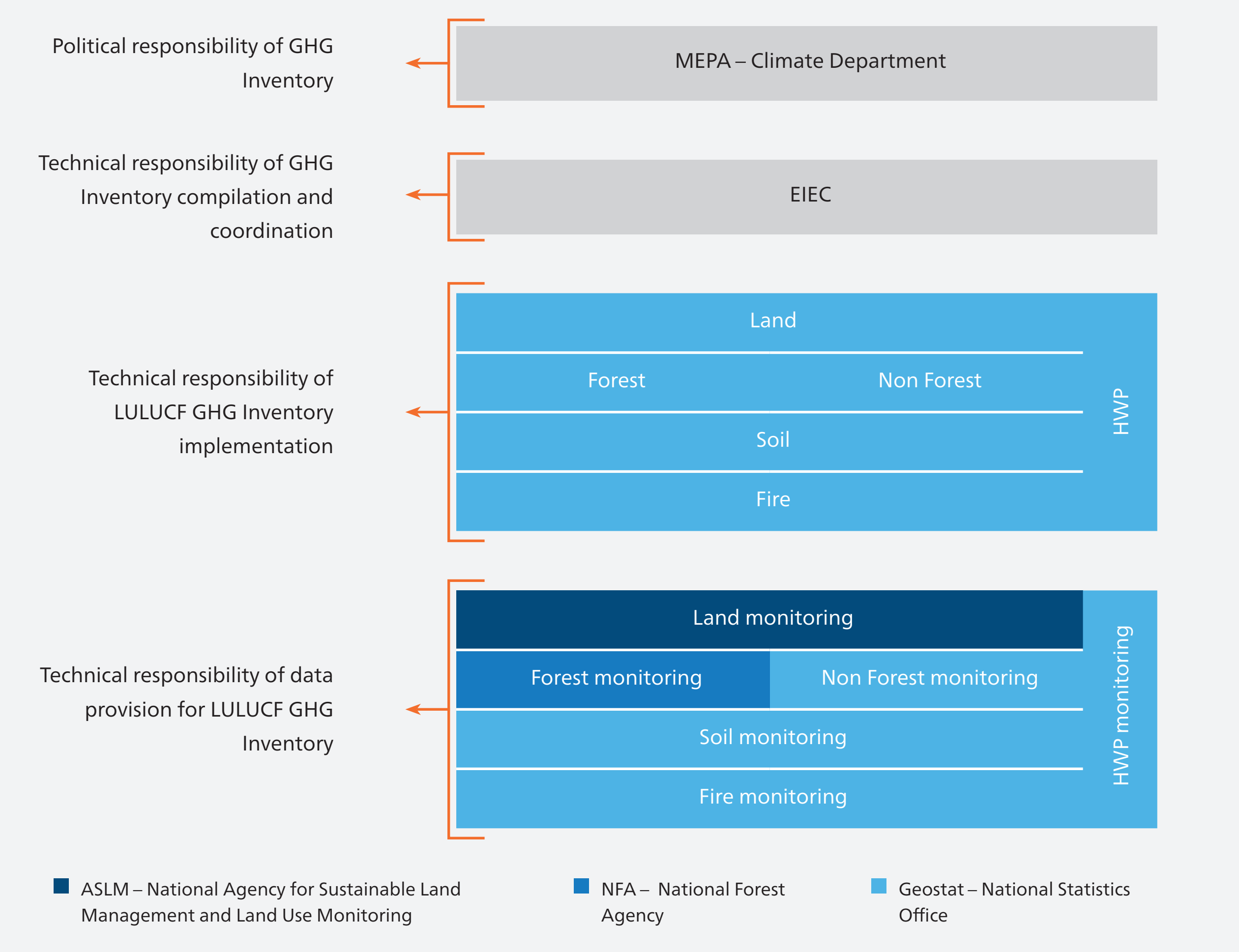


TABLE 11: STRENGTHS AND WEAKNESSES OF OPTION 3(A)

Strengths	Weaknesses
• High connection with data • High consistency of the inventory • Rather neutral position in administration • Easier mobilization of human resources (compared to MEPA staff)	• Possible low knowledge on IPCC procedures • Possible low involvement (no clue on Geostat involvement) • Lower expertise/knowledge in forest and agriculture • Low availability of technical teams

1.3.6. Option 3(b)

The option 3(b) gives the main responsibility of the LULUCF inventory to Geostat, the National Statistics Office, except for forest issues given to the National Forest Agency. It implies that:

- The LULUCF inventory is made externally by agencies partially dependent of MEPA.
- The LULUCF inventory is made by 2 structures that have high connection with data
- The forest part is made by 1 structure with high expertise for forest

FIGURE 10: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 3(B)

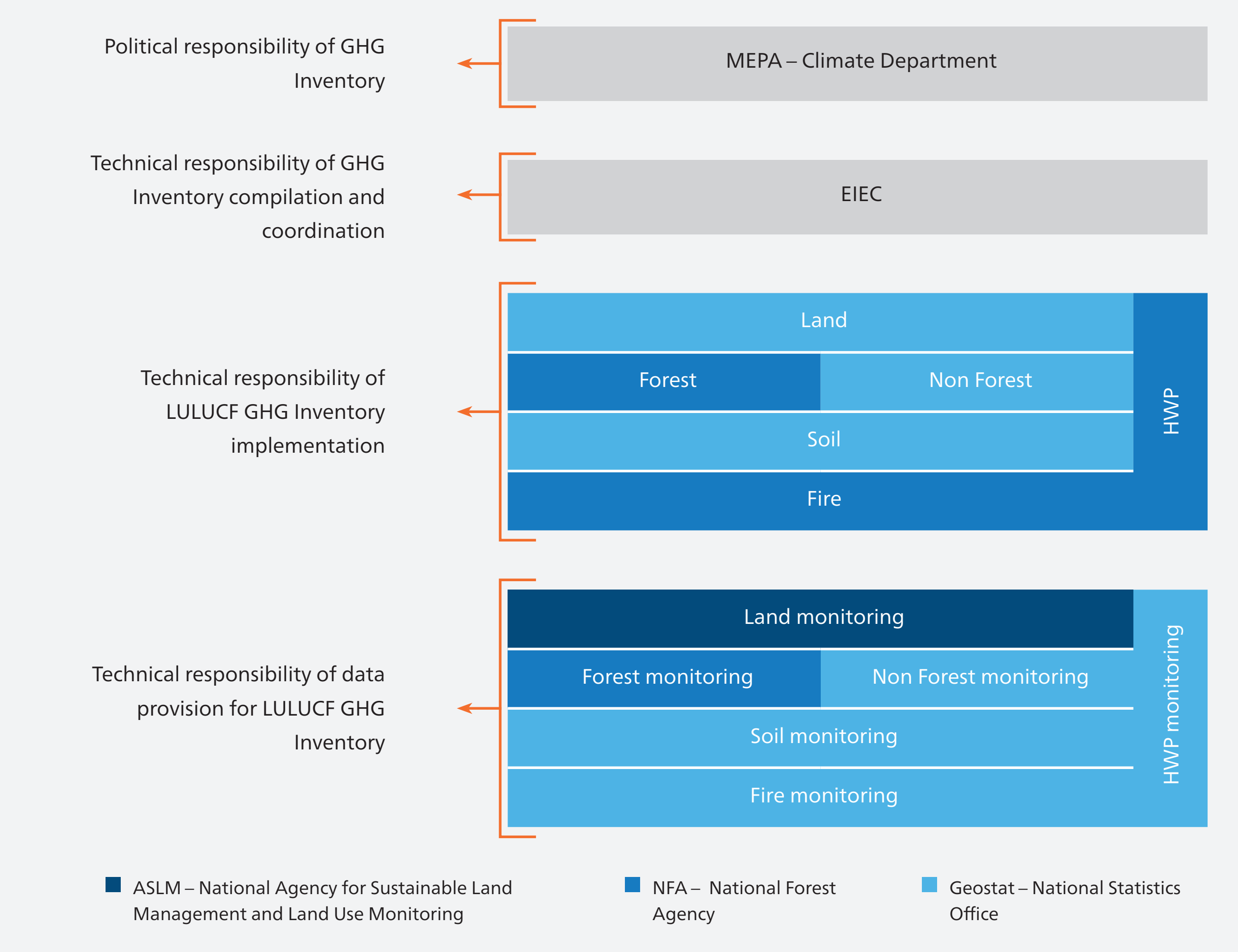


TABLE 12 : STRENGTHS AND WEAKNESSES OF OPTION 3(B)

Strengths	Weaknesses
• High connection with data • High connection with forest data • Easier mobilization of human resources (compared to MEPA staff)	• Possible concurrency in the leadership • Possible low knowledge on IPCC procedures • Possible low involvement (no clue on Geostat involvement) • Lower expertise/knowledge in agriculture

1.3.7. Option 4(a)

The option 4(a) gives the responsibility of the LULUCF inventory to the national forest agency. It implies that:

- The LULUCF inventory is made externally by an agency partially dependent of MEPA.
- The LULUCF inventory is made by 1 structure that have high connection with forest data.
- The LULUCF inventory is made by a structure that encompass its usual scope of work

FIGURE 11: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 4(A)

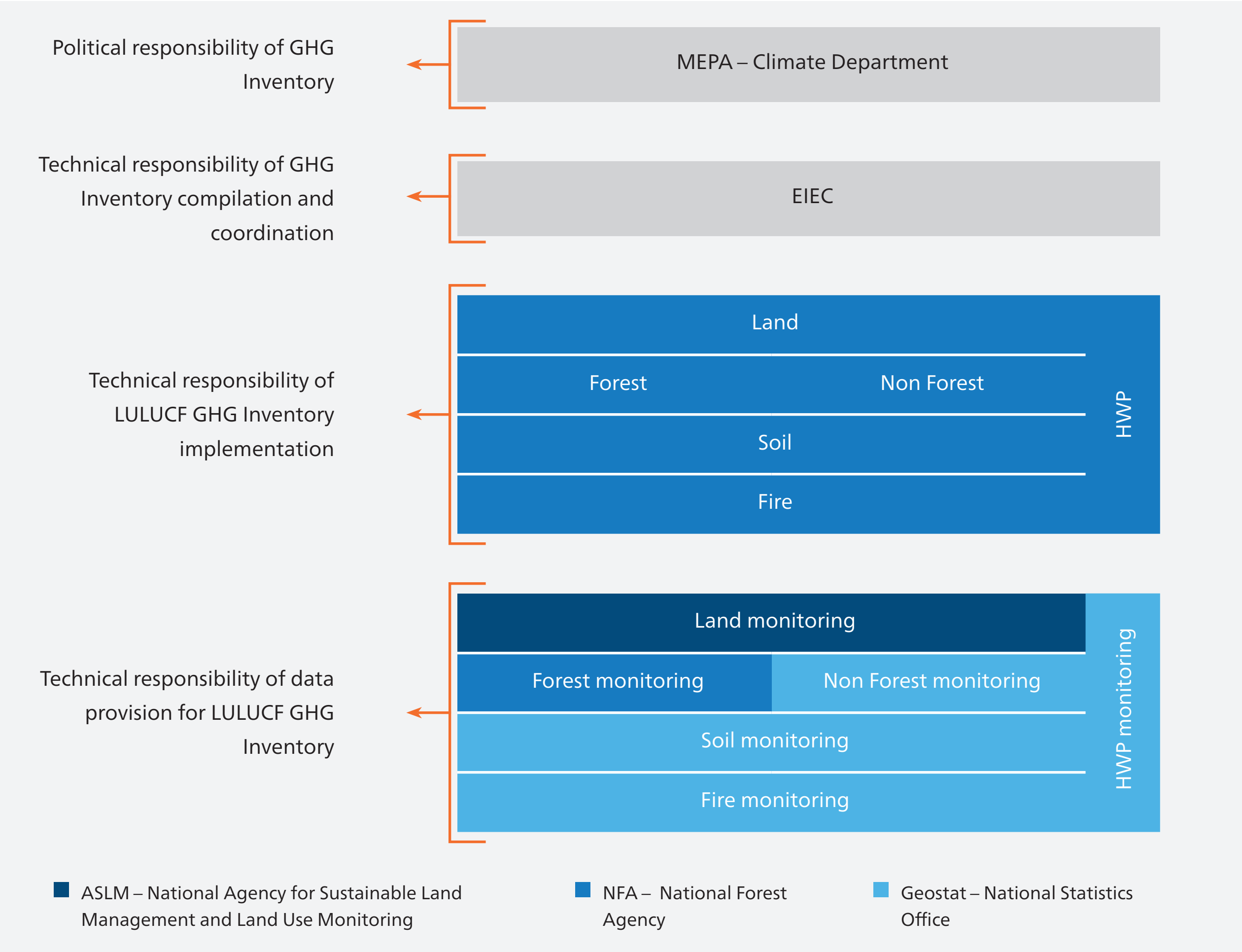


TABLE 13 : STRENGTHS AND WEAKNESSES OF OPTION 4(A)

Strengths	Weaknesses
• High connection with forest data • High consistency of the inventory • Technical teams • Easier mobilization of human resources (compared to MEPA staff)	• Possible conflict with other structures which were legitimately interested in this task • Possible low knowledge on IPCC procedures • Possible low involvement in agriculture issues • Lower expertise/knowledge in agriculture

1.3.8. Option 4(b)

The option 4(b) gives the main responsibility of the LULUCF inventory to the national forest agency, except for non-forest issues given to the National Statistics Office. It implies that:

- The LULUCF inventory is made externally by agencies partially dependent of MEPA.
- The LULUCF inventory is made by 2 structures that have high connection with data
- The forest part is made by 1 structure with high expertise for forest

FIGURE 12: DISTRIBUTION OF RESPONSIBILITIES IN OPTION 4(B)

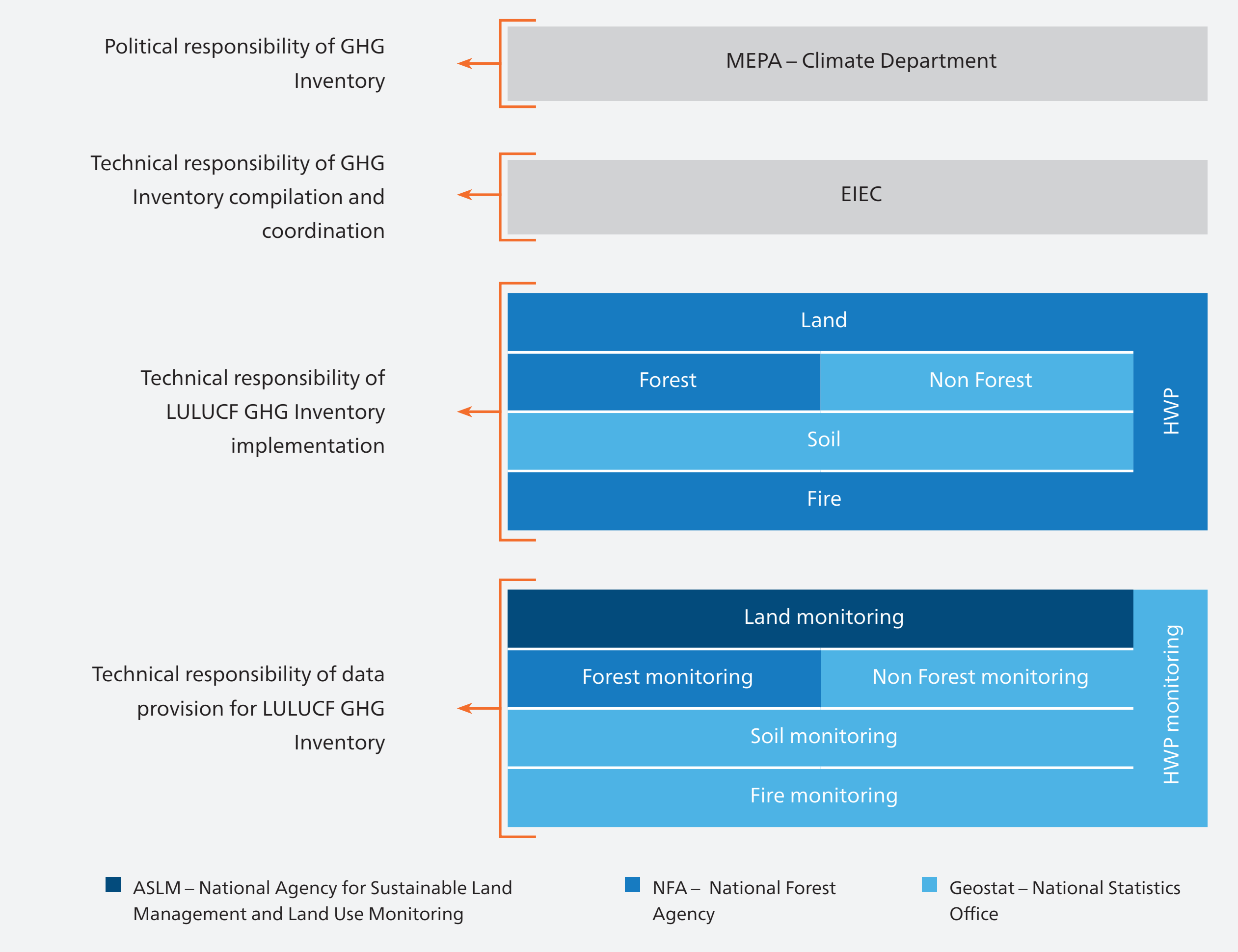


TABLE 14: STRENGTHS AND WEAKNESSES OF OPTION 4(B)

Strengths	Weaknesses
• High connection with forest data • Technical teams • Easier mobilization of human resources (compared to MEPA staff)	• Possible conflict with other structures which were legitimately interested in this task • Possible low knowledge on IPCC procedures • Possible low involvement in agriculture issues • Lower expertise/knowledge in agriculture • Possible gaps in consistency between subcategories

1.3.9. Option 5(a)

The option 5(a) gives the entire responsibility of the LULUCF inventory to an external organization (Agricultural university, State university…). It implies that:

- The LULUCF inventory is made by an external organization.
- The LULUCF inventory is made by 1 structure that have high scientific expertise.

FIGURE 13: DISTRIBUTION OF RESPONSIBILITIES IN OPTION A3

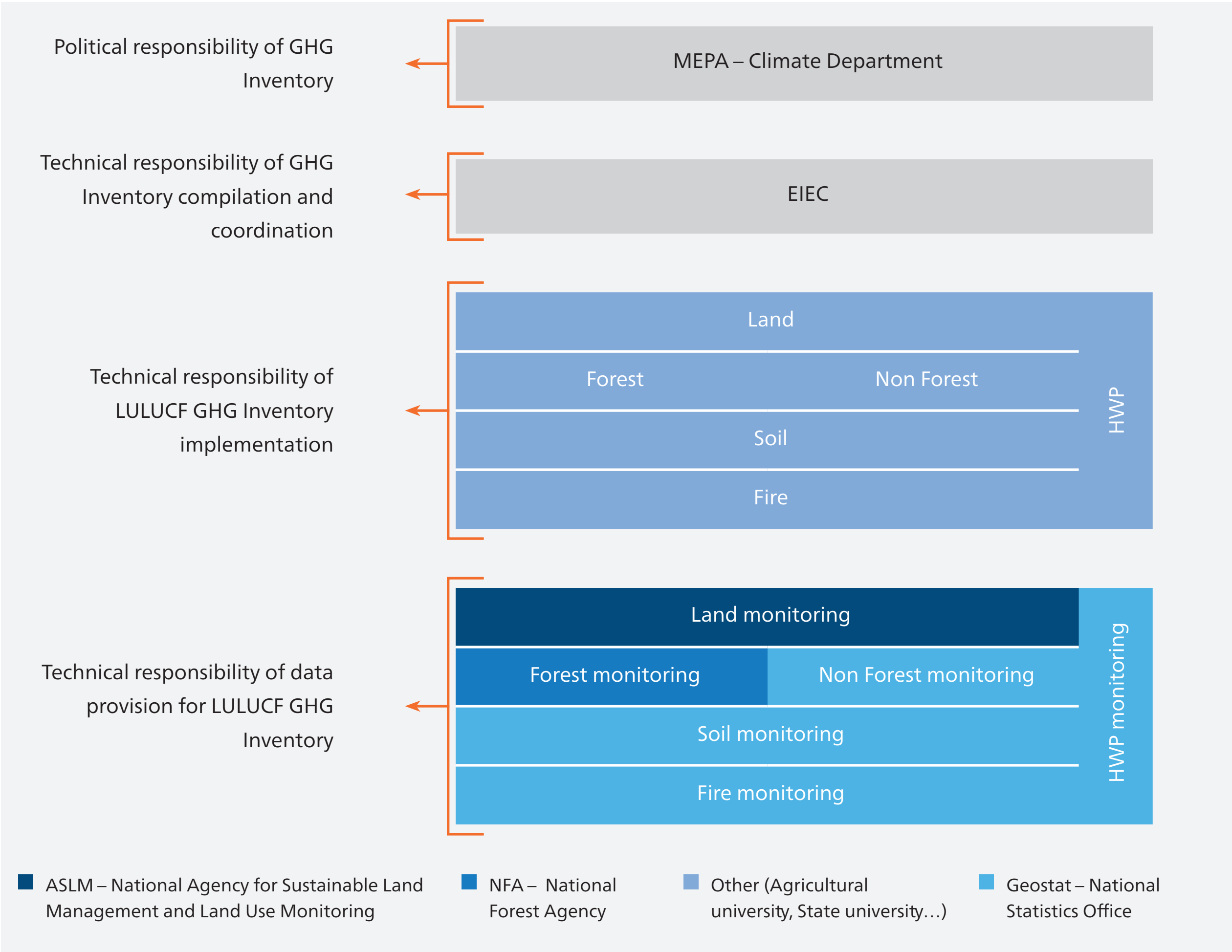


TABLE 15: STRENGTHS AND WEAKNESSES OF OPTION 5(A)

Strengths	Weaknesses
• High consistency among LULUCF sectors • High scientific background and expertise • Possible good knowledge on IPCC procedures • Possibly saving in terms of resources • Easy mobilization of human resources	• Possible low involvement (no clue on university involvement) • Possible low access to data • Possible low expertise in forest and agriculture economic sectors

1.4. CONCLUSION ON OPTIONS

The conclusion of this chapter concerns the choice of possible options.

The proposals of options were inspired from a benchmark led on European countries where various situations were observed. Indeed, among European countries a lot of systems can be seen, it shows the diversity of options and the fact that the proposed options are relevant.

TABLE 16: BENCHMARK OF LULUCF SYSTEM IN EUROPE

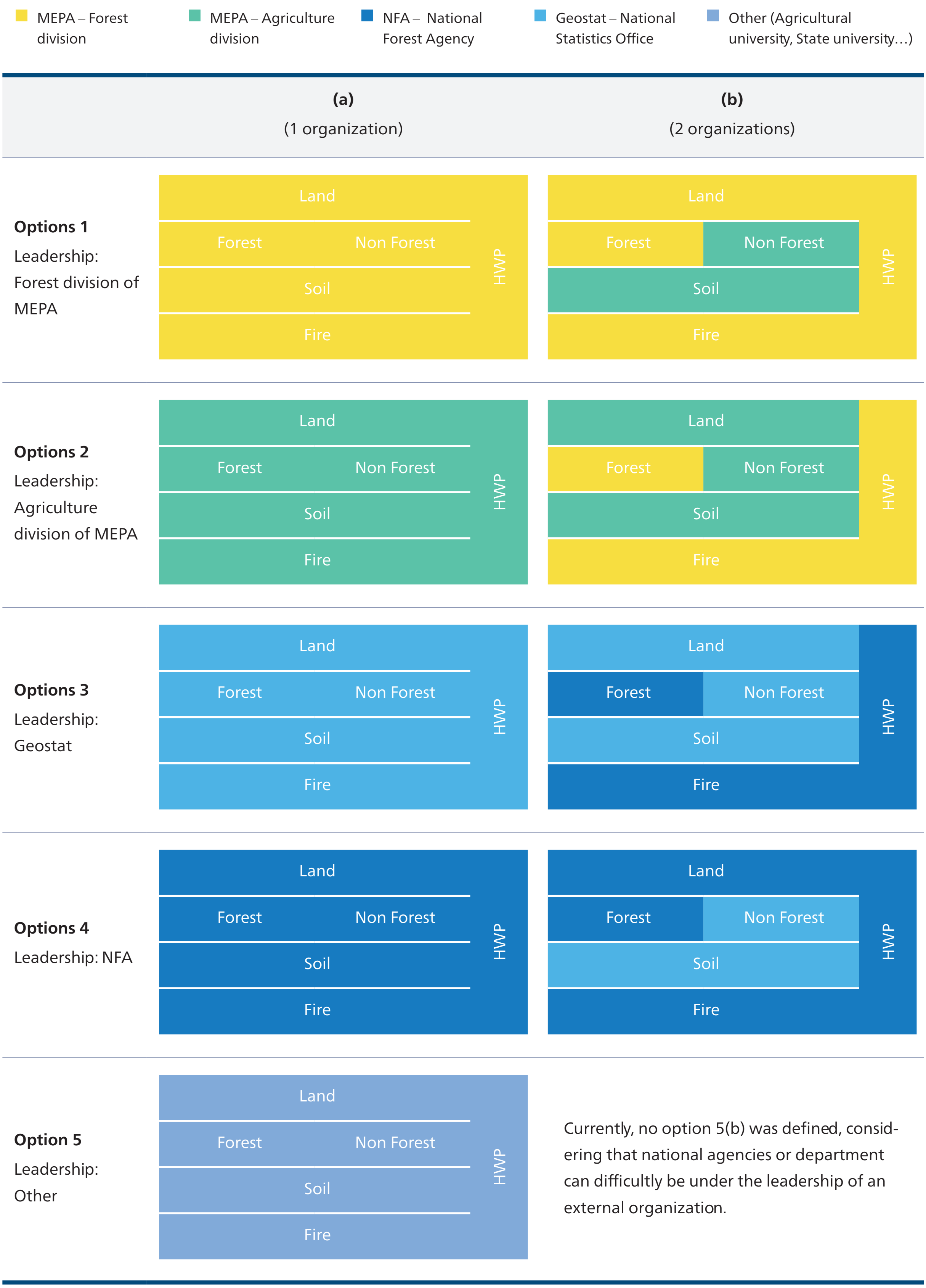
All by 1 generalist structure	All by 1 LULUCF structure (main scope)	By 2 LULUCF structures (main scopes)	By 3 LULUCF structures (main scopes)	By 4 LULUCF structures (main scopes)
Austria Belgium Bulgaria Croatia Cyprus France Greece Italy Ireland Luxembourg Poland Portugal Spain	Estonia (Forest) Finland (AFOLU) Germany (AFOLU) Iceland (Soil) Latvia (Forest) Netherlands (Agri). Norway (Forest) Sweden (Agri) United Kingdom (Forest & soil)	Czechia (Forest/Agri) Denmark (Forest/Agri) Hungary (Forest/Agri) Iceland (Forest/Agri) Lithuania (Forest/Agri) Slovenia (Forest/Agri)	Slovakia (Forest/Agri/soil)	Romania (Land/Forest/ Agri/soil)

A few comments on this benchmark:

- LULUCF remains the sector where there is often at least a dedicated structure. It reflects the difficulty for a generalist entity to make the inventory for LULUCF.
- A lot of countries are based on 2 structures, one for forest one for agriculture. It seems a good option, but it does not explicit how land monitoring is used and produced.
- the younger systems tend to have more structures involved and the oldest ones have generalist.
- Romania (now with 4 LULUCF structures involved) has just changed its system and involved a lot of expert structures to strengthen its work on LULUCF. Currently it seems that it works but of course it is much more demanding in terms of resources than other systems.

9 options are presented for Georgia, all of them may be good, there is no irrelevant system among them. The options only concern the technical responsibility of the LULUCF inventory, it implies differently existing structures in Georgia.

FIGURE 14: SUMMARY OF OPTIONS FOR THE TECHNICAL RESPONSIBILITY OF THE LULUCF INVENTORY



It is important to indicate that no obvious system was found for Georgia:

- Options based on MEPA's divisions (forestry or agriculture) may not be easy to manage because they should deal with internal funds and will certainly face difficulties in terms of human resources.
- Options based on agencies are not obvious because the scope and the missions of agencies does not fit very well with LULUCF categorizations. No specific agency was identified to manage non-forest issues for LULUCF.
- LULUCF is firstly based on land monitoring but the land agency, which could be relevant, does not really have the capacity to lead a LULUCF inventory. They consider they can be involved as data providers only.
- Geostat could be indicated as it is closely linked to data provision, but no contact was taken during the project. Moreover, statistical offices are often not very motivated by this type of task quite different from their main mission.
- No external stakeholder was clearly identified as fully relevant to lead the LULUCF inventory. No contact was taken with universities.

Considering these limitations, among all options presented, we consider that options 1(b), 3(a), 4(b), and 5(a) are the most promising options.

- Option 1(b) gives the leadership to the forest division at MEPA with the contribution of the agriculture division at MEPA. This choice is linked with the importance of forest in Georgia and the involvement of forest department in MRV systems. The main challenge with this option is certainly to mobilize human resources internally at MEPA.
- Option 3(a) gives the entire responsibility of the LULUCF inventory to Geostat. It is considered that Geostat could be a generalist entity capable to manage a LULUCF inventory by using available data. Yet no feedback from Geostat on this possibility was received.
- Option 4(b) gives the leadership to the national forest agency with the contribution of Geostat for non-forest issues. This choice is linked with the importance of forest in Georgia and the interest to imply agencies in such a work.
- Option 5(a) gives the entire responsibility of the LULUCF inventory to an external organization. It may be the easiest way at it is rather like the current situation where national experts are contracted. The involvement of scientific universities is often a guarantee of quality for LULUCF inventories. Yet no contact was taken with universities to further check the relevancy of this option.

The LULUCF sector may be treated with specific consideration and separately from the rest of the GHG inventory. Yet, the system should also take in consideration the other sectors of the GHG inventory. The system should not be chosen without considering the sector agriculture which may be much linked with LULUCF.

2. PROPOSED PROCEDURES TO ENSURE THAT ORGANIZATIONS AND INDIVIDUALS WILL PARTICIPATE AND COLLABORATE

2.1. NATIONAL INVENTORY SYSTEM DOCUMENT

2.1.1. Official mandates

The option chosen to organize national arrangements to set up a sustainable and robust system for national GHG inventory compilation, and in particular the LULUCF sector, needs to be formally established.

To do so, one or several documents, such as decrees, orders, or other relevant legal texts, shall be edited – or existing documents shall be updated.

To operationalize the Decree, bilateral/multilateral agreements should normally be established between the institutions involved, describing the areas of collaboration between these stakeholders in the context of the inventory.

Such document shall define the national system to conduct, on a permanent basis, national GHG inventory, its frequency and the roles and responsibilities of each organization. This document shall then officially mandate each organization, agency or other group to participate to the system.

This or these documents shall:

1. define (or remind) the **political responsibility of GHG Inventory**, for which the Climate division of MEPA is responsible, with the consultative role of the Climate Change Council (CCC). The document would list the typical obligations associated with this level of responsibility, such as officially submitted reporting elements to the UNFCCC secretariat, tracking the evolution of international requirements, and ensuring a link between government policy action and GHG inventory.
2. define the **technical responsibility of GHG Inventory compilation and coordination**, for which the EIEC is supposed to be responsible. The document would then clarify EIEC role and budget allocation rules regarding this function. The specific missions, agenda and deliverables expected from this role are also to be explicitly listed. In particular, this level of responsibility shall include:

- the compilation of all sectoral results into consistent documents and tables.
- the preparation of Terms of Reference for the organisation(s) responsible for the technical work on LULUCF GHG Inventory implementation.
- the updating of an improvement plan of the inventory.
- the regular organization of meetings ensuring the follow-up of the inventory compilation of each sector and the respect of the terms of reference.

3. define the **technical responsibility of LULUCF GHG Inventory implementation**, for which different organizations could be responsible for, as presented in the different options within the present report. The specific missions, agenda and deliverables expected from this role are also to be explicitly listed.
4. define the **technical responsibility of data provision for LULUCF GHG Inventory**, for which different organizations could be responsible for, as presented in the different options within the present report. The types of data expected could be presented, without specifically name precise datasets, since they can evolve. Instead, it should be stated there that data providers are mandated to provide directly and with no cost datasets fitting the needs expressed by the organization(s) responsible for the technical responsibility of LULUCF GHG Inventory implementation.

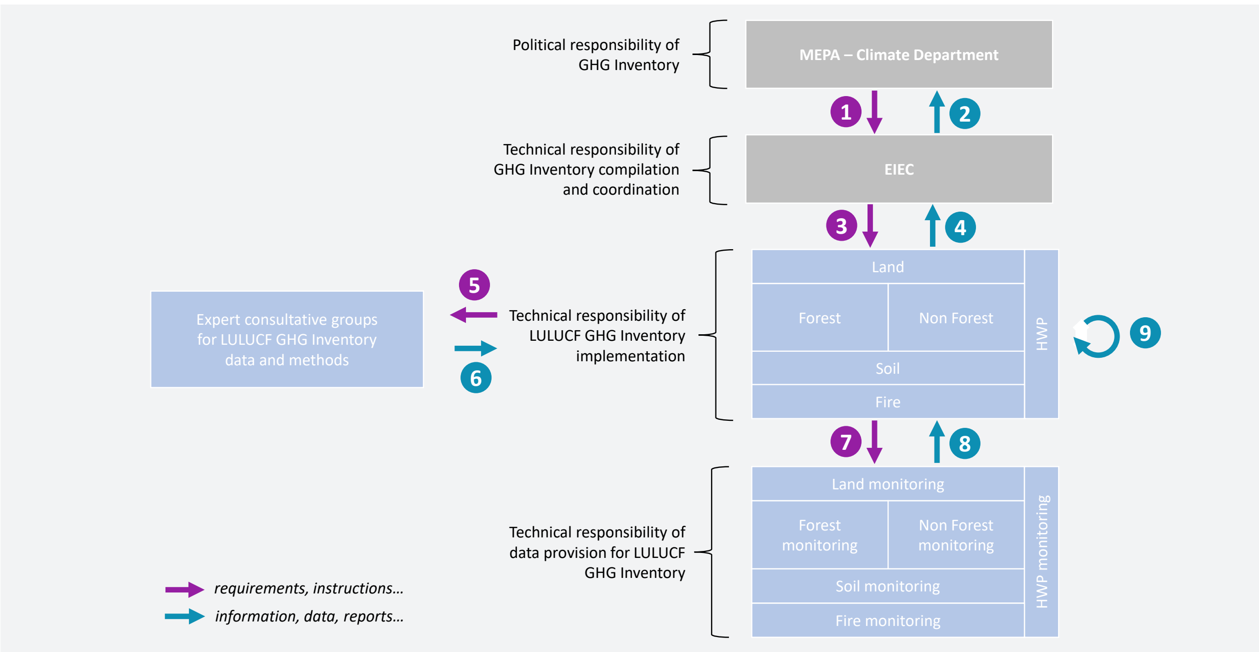
We identify two ways to establish such a document:

- Either a unique National Inventory System Document (NISD) is drafted by MEPA, with the participation of EIEC.
- Or two documents are drafted. One document is prepared to cover points 1. and 2. of the list presented above, and a second document is prepared to cover points 3 and 4. This allows updates of the second document to be easier and to be agreed upon more swiftly.

2.1.2. Collaborations to be formally agreed upon

In this or these documents, specific collaborations between organizations and experts shall be presented. These collaborations can be requirements (instructions, orders, terms of reference…) or information (data, reports, oral or written explanations…). These collaborations are summarized below:

FIGURE 15: COLLABORATION, MANDATES, RESULT PROVISION, DATA PROVISION



Legend

❶ Updates on international requirements evolution (Paris Agreement, CRT, etc.); National indicators requirements (for NDC updating and action follow up, national strategy for mitigation…); Policy priorities and associated needs for inventory improvement .. Recommendations of the Climate Change Council (CCC)…;

❷ Draft final reports (National Inventory Reports (NIR), Nationally-Determined Contributions (NDC), Biennial Transparency Reports (BTR), National Communications (NC)…), Indicators for national climate strategy…;

❸ Terms of Reference for the compilation of the inventory: sectors and subsectors to be estimated, priorities, deadlines, data reporting formats, improvement plan…;

❹ Intermediate and final results of emissions and removals for all sectors, methodological reports, other information required in the terms of reference;

❺ Identification and invitation of experts and setting up of meetings for thematic advisory working groups;

❻ Provision of information and expertise on LULUCF topics and technical work from the organization in charge of the technical work on LULUCF GHG inventory;

❼ Exchange of data and assumptions to ensure consistency between LULUCF subcategories. In particular, land-use categories definitions and areas are to be estimated by the experts assigned in the "Land" component, and used by other components if needed (e.g. for carbon stock change due to land use conversion, in the "soil", "forest" and "non-forest" components. The experts assigned in the "Land" component have an overview role to ensure such consistency. Other key parameters such as biomass carbon stocks, soil carbon stocks, climate zones, etc., are also to be shared and discussed between the different experts, and used consistently. Specific assumptions (e.g. default assumption of equilibrium of a specific pool) have also to be shared and discussed.

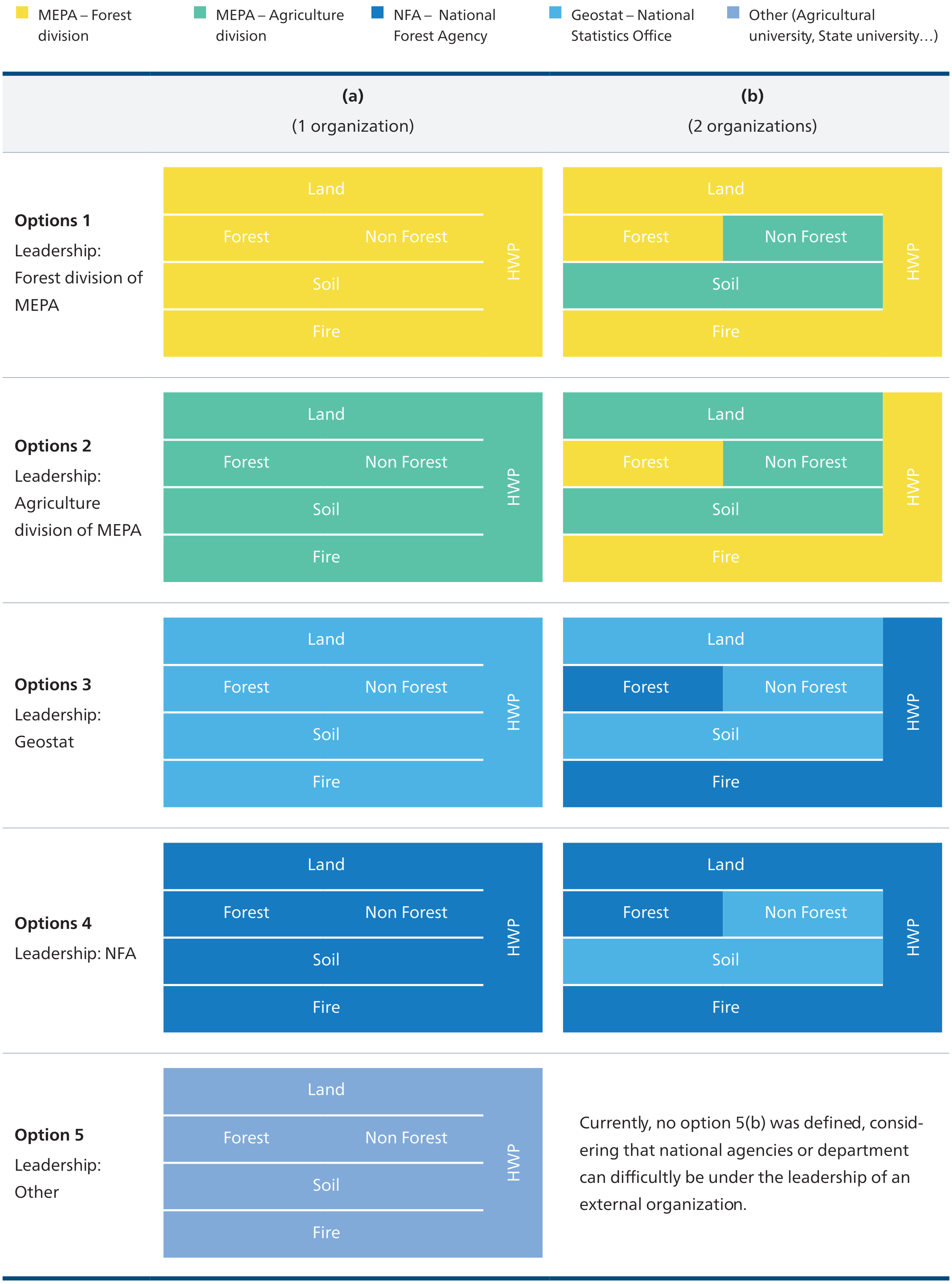
❽ Data needs, with specific requirements of the LULUCF inventory. For example, land-use areas must be compatible with IPCC definitions of the six main land use categories, compatible with the country's official forest definition, and compatible with the need to reconstruct annual land use change matrices from 1970.

❾ Direct communication of information and datasets, with additional explanations regarding definitions, units, data limits, possible uses, spatial and temporal consistency, and representativity for the whole country.

2.2. TECHNICAL RESPONSIBILITY FOR LULUCF INVENTORY

Different arrangements and procedures can be considered for each of the options proposed in section 2 of this report, which are summarized below.

FIGURE 16: SUMMARY OF OPTIONS FOR THE TECHNICAL RESPONSIBILITY OF THE LULUCF INVENTORY



Option 1(a) gives the entire responsibility of the LULUCF inventory to the Forest Division of MEPA. The Forest Division should organize and plan the elaboration of the LULUCF inventory and be the main actor for the LULUCF calculations. Option 1(b) let the main responsibility of the LULUCF inventory to the Forest Division of MEPA but officializes the responsibility of the agriculture division of MEPA on non-forest topics. This option implies a higher collaborative exercise between the Forest Division and the Agriculture Division of MEPA, eventually with the assistance of the Climate Change Division for methodological purposes. In order to arrange for the organization and planning of the LULUCF inventory, a Memorandum of Understanding could be agreed upon by their respective departments in order to specify who is doing what, when and how, including budgetary implications and human resources' allocation.

With options 2(a) and 2(b), the LULUCF inventory is still made internally by MEPA but the leadership is given to the Agriculture division of MEPA.

Options 1 and 2 do not exclude a collaborative work with other MEPA departments, divisions and agencies. A Task Force for LULUCF Inventory may for instance be proposed, bringing together representatives of the Forest Division, the Department of Agriculture, Food and Rural Development, the Department of Environment and Climate Change, the Department of Policy Coordination and Analysis, and the Department of Biodiversity and Forestry. NFA, APA and ASLM could be involved as observers. The Task Force would be chaired by the Director General of the Forest Division and supported by the Climate Change Division on the methodological aspects of the inventory for the proper application of the IPCC Guidelines.

Options 3 and 4 are different to the extent that the technical responsibility for implementing the LULUCF inventory is mainly allocated to agencies having relevant expertise and data connection. Among agencies, only Geostat and the National Forest Agency (NFA) seem capable to carry out a LULUCF inventory. Both are under MEPA's supervision.

Option 5(a) shows that it would be also possible to have other structures out of MEPA's supervision with for instance a university. Some arrangements should be put in place to ensure data provision.

2.3. TECHNICAL RESPONSIBILITY FOR DATA PROVISION

Having in mind that data collection is based on a large panel of actors and that LULUCF inventory is usually done with existing statistical data in most UNFCCC Parties, priority should be given to data accessibility. The assurance that data will be provided by those who will be tasked with the technical responsibility can be given through different arrangements that may be combined:

- Access to information: one proposal can be that all relevant information for the establishment of the LULUCF inventory should be made available for those institutions that will be tasked with the technical responsibility for LULUCF inventory implementation (see section 3.1 above). This means that those institutions could specify what data is relevant for LULUCF inventory and request from the data collectors their provision when necessary for the elaboration of the LULUCF inventory (e.g. supposedly every two years, for the BTR).

- Partnership with the National Statistics Office (NSO): another proposal can be that those institutions tasked with the technical responsibility for LULUCF inventory implementation engage a partnership with NSO to get the relevant data for LULUCF inventory. Such partnership should specify all data that can be relevant for LULUCF inventory. It would be then the responsibility of the NSO to make sure existing statistics are sufficient and, if not, to obtain them from data providers in all sectors, including those who work under the supervision of MEPA. In any case, the partnership should be signed at the level of the two General Secretariats of NSO and MEPA, with the agreement of the Prime Minister Services.
- Put a regulatory obligation on data providers to collect relevant data: this is the most radical proposal to get the assurance that the most up to date data is provided in a timely manner, eventually in the prescribed format in advance. Given the multitude of sectors concerned by LULUCF, it would be logical to have this regulatory obligation set for all Governmental members and bodies through an administrative Decree signed by the Prime Minister. However, this would certainly have budgetary implications for all of them.

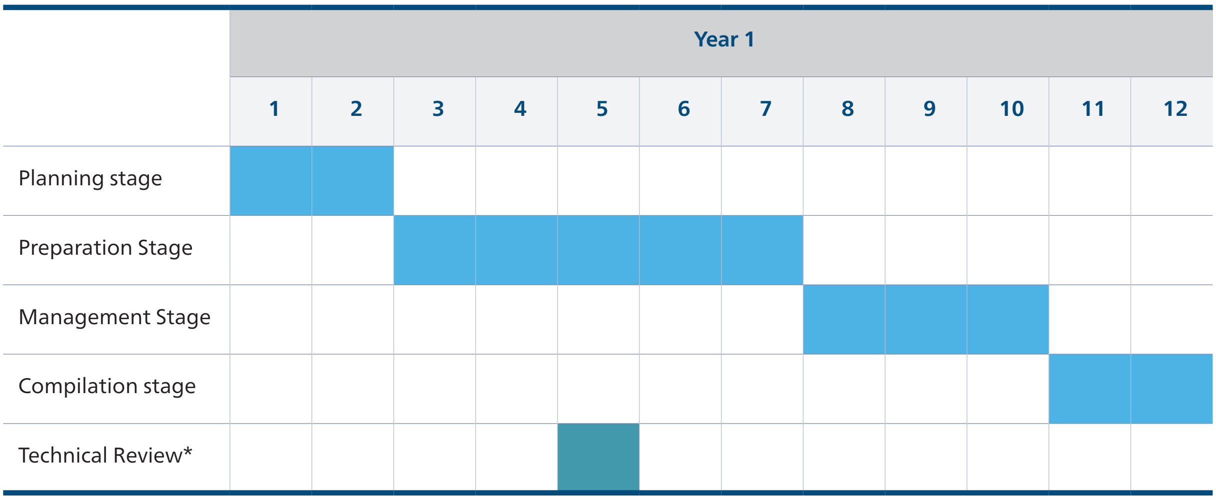
To facilitate the exchange of Data Supply Agreement (DSA) or Memorandum of Understanding (MoU) can be signed between data providers and data users. A template for MoU is provided in annex 1 of this report.

3. PROPOSED WORKPLAN FOR LULUCF INVENTORY

The schedule can be designed for an annual frequency or a biennial frequency. It seems that the annual frequency is more expensive that the biennial one, in practice it is not obvious because routines are much easier to implement on an annual basis than on 2 years. As far as possible annual schedule should be prioritized.

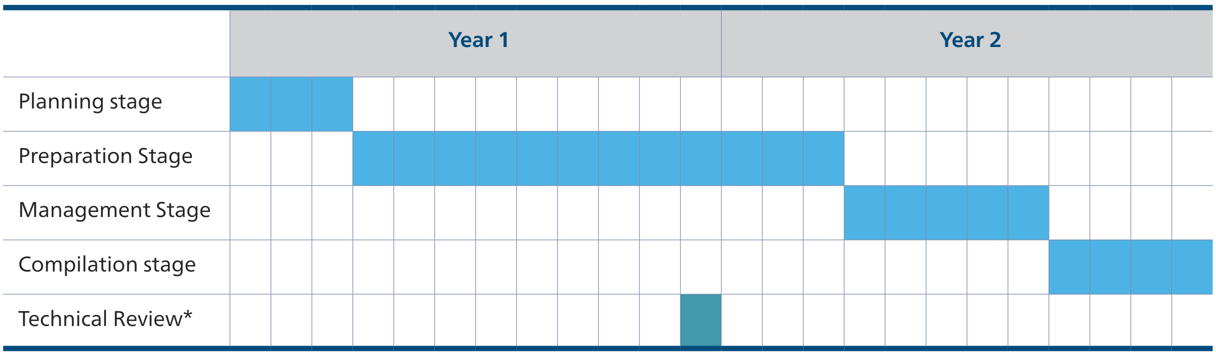
The following figures show possible workplan, ideally it would be more detailed by task and responsibility.

FIGURE 17: POSSIBLE WORKPLAN WITH ANNUAL FREQUENCY



* of the previous edition of inventory

FIGURE 18: POSSIBLE WORKPLAN WITH BIENNIAL FREQUENCY



* of the previous edition of inventory

One must also indicate that the 2019 IPCC refinement give a very good example of workplan in Table 1.6.

3.1. PLANNING STAGE

Possible tasks for this stage:

- Review of preview estimates, procedures, feedback, comments from official or informal technical review, and list of planned improvement.
- Establish or update Inventory protocols and guidelines containing instructions and procedures for preparing the inventory.
- Form or activate inventory-working groups for the inventory sectors and cross-cutting issues.
- Formulate and sign or confirm memorandum of Understanding (MoU) among inventory institutions. The MoUs define specific functions of inventory institutions relating to estimation etc.
- Organize meetings of the working groups
- Training for inventory teams to ensure readiness and distribute overall and sector inventory instructions, provide relevant training to teams.
- Organize kick-off meetings.

3.2. PREPARATION STAGE

Possible tasks for this stage:

- Identification and review of data sources including choices of data, methodologies, and software.
- Data request, data review, evaluation, and documentation
- Review performance of existing tools and where necessary making changes to work efficiently.
- Review performance of data storage and where possible making necessary corrections
- GHG estimation and text files for each source/removal (see simplified guidelines to have an overview on methodology and main calculations)
- Quality control
- All worksheets and documentations submitted
- Compile zero order draft of inventory and submit to inventory coordinator

3.3. MANAGEMENT STAGE

Possible tasks for this stage:

- Distribute zero-order drafts for internal review
- Distribute source files (tools, worksheets) and internal review to lead institutions
- Incorporate internal comments, observations, and corrections
- Collect uncertainty values from sectors and quantify uncertainty for the overall inventory.

- Compile second order draft of inventory and revise worksheets
- External review of second order inventory (Quality Assurance)
- Incorporate external comments and revise worksheets

3.4. COMPILATION STAGE

Possible tasks for this stage:

- Draft improvement strategy
- Collect all pertinent paper and electronic source materials for archiving place in archive due national archiving and documentation institution
- Compile final Inventory and preparation of key category analysis
- Compile inventory improvement strategy
- Compilation of National Inventory Report (NIR)
- NIR submitted to National Inventory Entity for incorporation into National Communication and Biennial Update Report
- Dissemination of NIR – Submission to UNFCCC, inventory is available for public release

3.5. TECHNICAL REVIEW

Possible tasks for this stage:

- Coordinate the technical review process
- Compile all comments, feedback, and planned improvement list

4. SIMPLIFIED GUIDELINES AND INFORMATION FOR NATIONAL EXPERTS TO PROCESS LULUCF INVENTORY

The LULUCF sector of the national GHG inventory is a complex product. To manage it, inventory compilers are guided by the IPCC guidelines. Currently, the 2006 IPCC guidelines are the basis. They are refined by the 2019 IPCC refinement but for LULUCF only few cases are significantly different. For wetlands the 2013 IPCC complement on wetlands is also recommended.

It is not easy nor relevant to produce alternative guidelines to the 2006 guidelines for LULUCF. In this project, a few elements considered as the major ones are presented as simplified elements of guidelines. It does not replace the official guidelines but introduce a selection of major equations that are used in LULUCF inventories.

- General methodology for land monitoring
- General methodology for estimating carbon fluxes
- Main calculations
  - Calculation of carbon fluxes in biomass of forest lands
  - Calculation of carbon fluxes in woody crops
  - Calculation of carbon fluxes for conversions of land use
  - Calculation of carbon fluxes in soil organic matter
  - Calculation of other emissions from soils
  - Calculation of emissions related to burning
  - Calculation of carbon fluxes due to harvested wood products (HWP)

By screening these elements on LULUCF, a national expert should understand the main objectives and possibilities to implement a LULUCF inventory.

Informal recommendations are also presented in these simplified guidelines, they are based on our experience of inventories and not directly mentioned in the official IPCC guidelines. These recommendations are subjective recommendations and may lead to discussions among LULUCF experts. It remains the responsibility of the national teams to select useful information.

4.1. GENERAL INFORMATION ON THE SECTOR

The Land Use, Land Use Change and Forestry (LULUCF) sector is a category that aggregates GHG emissions but also removals. It is focused on the variation of the carbon stocks from the different carbon pools (living biomass, soil organic matter…), and some related emissions (emissions from burning on non-agricultural sites...).

Emissions and removals are expected for the following land use categories:

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

This sector LULUCF also includes the category "harvested wood products" (HWP) which is independent of land use, but connected to land management and wood production.

4.2. GENERAL METHODOLOGY FOR LAND MONITORING

The first step in estimating emissions and removals is to monitor the evolution of land uses. The 2006 IPCC guidelines offer 3 approaches of increasing precision and difficulty to assess land use changes:

- Approach 1: representation of land without monitoring the evolution of each category of land,
- Approach 2: use of land use change matrices on a sample and extrapolation to the entire territory,
- Approach 3: Use of land use change matrices with comprehensive coverage and the ability to spatially represent a land use change map. Approach 3 is most often the result of work from satellite images but can also in theory be implemented from statistical sampling.

To carry out land monitoring for LULUCF inventories, several collection techniques are possible:

- Field surveys
- Photo-interpretation
- Mapping known as "wall to wall"

Regardless of the basic data used, the implementation of land monitoring for the national inventory is always one of the major challenges for inventory compilers. It most often results in the production of land use change matrices like the one presented below.

FIGURE 19 : POSSIBLE REPRESENTATION OF LAND USE CHANGES WITH A MATRIX

	Forest	Cropland	Grassland	Wetland	Settlement	Other land	Initial Area
Forest							
Cropland							
Grassland							
Wetland							
Settlement							
Other land							
Final Area							

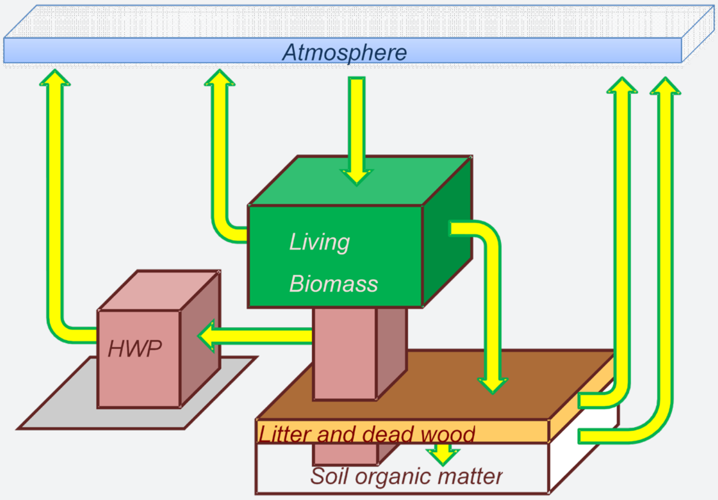
TABLE 17: INFORMAL RECOMMENDATIONS ON LAND MONITORING (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 1	*We recommend focusing first on land use changes for all land use changes between the 6 categories of land and to estimate annual land use changes before implementing any matrix. The lands without changes (i.e. Forestland remaining forestland) must be calculated by difference between the total area of a land use and the sum of lands converted to this land use.*
Reco 2	*We recommend using only one year as reference for land areas and to use land use change areas to calculate the entire time series.*
Reco 3	We recommend estimating land use changes since 1970 to avoid artificial changes in land use change rates for the period 1990-20xx, even if it is a basic extrapolation.
Reco 4	We recommend being very cautious by comparing maps that are made with different methods. A lot of irrelevant land use changes may appear.
Reco 5	We recommend dealing woody crops as a land use subcategory of Cropland (which is not the case in the IPCC).
Reco 6	We recommend being very cautious when using different climate zones. It may be more reasonable to keep only one zone and to simplify calculations. Indeed, the split of the territory into climate zone must be applied for all parameters once it is chosen and can therefore increase the working time
Reco 7	We recommend verifying the consistency of the global territory covered by the inventory over the entire time series. The category Other Land can be used as a "remaining category" to ensure this consistency.

4.3. GENERAL METHODOLOGY FOR ESTIMATING CARBON FLUXES

The LULUCF inventory requires the assessment of all carbon fluxes between terrestrial carbon pools and the atmosphere. The principle of these carbon fluxes between pools can be summarized as follows:

FIGURE 20: SCHEME OF CARBON POOLS AND CARBON FLUXES



The equation 2.3 of 2006 IPCC Guidelines presents all these carbon fluxes.

Equation 1: Annual carbon stock for a stratum of land-use category (Equation 2.3, 2006 IPCC guidelines)

EQUATION 2.3

ANNUAL CARBON STOCK CHANGES FOR A STRATUM OF A LAND-USE CATEGORY AS A SUM OF CHANGES IN ALL POOLS

$$\Delta C_{LU_i} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SO} + \Delta C_{HWP}$$

Where:

ΔC_{LU_i} = carbon stock changes for a stratum of a land-use category

Subscripts denote the following carbon pools:

AB = above-ground biomass

BB = below-ground biomass

DW = deadwood

LI = litter

SO = soils

HWP = harvested wood products

Two calculation methods are proposed by the IPCC to estimate carbon stock and fluxes: a flux method (Gains – losses) and a stock change method. Depending on the pool and the type of land, one method or the other is preferred.

Equation 2 : Gains-losses method (Equation 2.4 2006 IPCC guidelines)

ΔC_L = annual loss of carbon, tonnes C yr^{-1}

EQUATION 2.4
ANNUAL CARBON STOCK CHANGE IN A GIVEN POOL AS A FUNCTION OF GAINS AND LOSSES (GAIN-LOSS METHOD)

$$\Delta C = \Delta C_G - \Delta C_L$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

ΔC_G = annual gain of carbon, tonnes C yr^{-1}

Equation 3: Stock change method (Equation 2.5, 2006 IPCC guidelines)

EQUATION 2.5
CARBON STOCK CHANGE IN A GIVEN POOL AS AN ANNUAL AVERAGE DIFFERENCE BETWEEN ESTIMATES AT TWO POINTS IN TIME (STOCK-DIFFERENCE METHOD)

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

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

C_{t_1} = carbon stock in the pool at time t_1, tonnes C

C_{t_2} = carbon stock in the pool at time t_2, tonnes C

4.4. MAIN CALCULATIONS

4.4.1. Calculation of carbon fluxes in biomass of forest lands

CO2 emissions and removals from forest living biomass are estimated either by Gains-Losses method (by difference between tree increment and wood harvest and/or disturbances) or by stock change method.

Equation 4: Biomass increment in forest (Equation 2.10, 2006 IPCC guidelines)

EQUATION 2.10
AVERAGE ANNUAL INCREMENT IN BIOMASS
Tier 1

$$G_{TOTAL} = \sum \{G_W \bullet (1+R)\}$$ Biomass increment data (dry matter) are used directly

Tiers 2 and 3

$$G_{TOTAL} = \sum \{I_V \bullet BCEF_I \bullet (1+R)\}$$ Net annual increment data are used to estimate G_W by applying a biomass conversion and expansion factor

Where:

G_{TOTAL} = average annual biomass growth above and below-ground, tonnes d. m. ha^{-1} yr^{-1}

G_W = average annual above-ground biomass growth for a specific woody vegetation type, tonnes d. m. ha^{-1} yr^{-1}

R = ratio of below-ground biomass to above-ground biomass for a specific vegetation type, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$. R must be set to zero if assuming no changes of below-ground biomass allocation patterns (Tier 1).

I_V = average net annual increment for specific vegetation type, m^3 ha^{-1} yr^{-1}

$BCEF_I$ = biomass conversion and expansion factor for conversion of net annual increment in volume (including bark) to above-ground biomass growth for specific vegetation type, tonnes above-ground biomass growth (m^3 net annual increment)$^{-1}$, (see Table 4.5 for Forest Land). If $BCEF_I$ values are not

available and if the biomass expansion factor (BEF) and basic wood density (D) values are separately estimated, then the following conversion can be used:

$$BCEF_I = BEF_I \bullet D$$

Equation 5: Biomass losses due to wood removals in forest (Equation 2.12, 2006 IPCC guidelines)

EQUATION 2.12
ANNUAL CARBON LOSS IN BIOMASS OF WOOD REMOVALS

$$L_{wood-removals} = \{H \bullet BCEF_R \bullet (1+R) \bullet CF\}$$

Where:

$L_{wood-removals}$ = annual carbon loss due to biomass removals, tonnes C yr^{-1}

H = annual wood removals, roundwood, m^3 yr^{-1}

Where:

$L_{wood\text{-}removals}$ = annual carbon loss due to biomass removals, tonnes C yr^{-1}

H = annual wood removals, roundwood, $m^3\ yr^{-1}$

R = ratio of below-ground biomass to above-ground biomass, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$. R must be set to zero if assuming no changes of below-ground biomass allocation patterns (Tier 1).

CF = carbon fraction of dry matter, tonne C (tonne d.m.)$^{-1}$

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tonnes biomass removal (m^3 of removals)$^{-1}$, (see Table 4.5 for Forest Land). However, if $BCEF_R$ values are not available and if the biomass expansion factor for wood removals (BEF_R) and basic wood density (D) values are separately estimated, then the following conversion can be used:

$$BCEF_R = BEF_R \bullet D$$

Equation 6: Biomass losses due to fuelwood removals in forest (Equation 2.13, 2006 IPCC guidelines)

EQUATION 2.13
ANNUAL CARBON LOSS IN BIOMASS OF FUELWOOD REMOVAL

$$L_{fuelwood} = [\{FG_{trees} \bullet BCEF_R \bullet (1+R)\} + FG_{part} \bullet D] \bullet CF$$

Where:

$L_{fuelwood}$ = annual carbon loss due to fuelwood removals, tonnes C yr^{-1}

FG_{trees} = annual volume of fuelwood removal of whole trees, $m^3\ yr^{-1}$

FG_{part} = annual volume of fuelwood removal as tree parts, $m^3\ yr^{-1}$

R = ratio of below-ground biomass to above-ground biomass, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$; R must be set to zero if assuming no changes of below-ground biomass allocation patterns. (Tier 1)

CF = carbon fraction of dry matter, tonne C (tonne d.m.)$^{-1}$

D = basic wood density, tonnes d.m. m^{-3}

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to biomass removals (including bark), tonnes biomass removal (m^3 of removals)$^{-1}$, (see Table 4.5 for Forest Land). If $BCEF_R$ values are not available and if the biomass expansion factor for wood removals (BEF_R) and basic wood density (D) values are separately estimated, then the following conversion can be used:

$$BCEF_R = BEF_R \bullet D$$

TABLE 18 : INFORMAL RECOMMENDATIONS ON BIOMASS OF FOREST (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 8	*We recommend being very cautious by using expansion and conversion factors. They are rather difficult to choose correctly. In case of doubt don't hesitate to use basic increment in dry matter.*
Reco 9	*We recommend crosschecking data on wood harvest and wood consumption to estimate a robust Figure for total harvest.*

Reco 10	*We recommend considering trees out of forest in the estimate of wood harvest to avoid overestimates of harvest in forestlands.*
Reco 11	*We recommend double checking of the scope of units (volumes, tonnages) for increment and wood removals.*
Reco 12	*We recommend crosschecking data on stocks and data on fluxes by making a carbon assessment of biomass in forest.*
Reco 13	*We recommend not forgetting mortality of trees as a disturbance in carbon balance of lands.*
Reco 14	*We recommend specifying wood removals on deforested areas and prevent any double counting of these losses.*

4.4.2. Calculation of carbon fluxes in biomass of woody crops

Carbon fluxes can be estimated thanks to a Gains-losses method with default value provided in Table 5.1 of the 2016 IPCC guidelines.

TABLE 7: PARAMETERS TO ESTIMATE BIOMASS GAINS AND LOSSES FOR WOODY CROPS (TABLE 5.1, 2006 GUIDELINES)

Table 5.1
Default Coefficients For Above-Ground Woody Biomass And Harvest Cycles In Cropping Systems Containing Perennial Species

Climate Region	Above-Ground Biomass Carbon Stock At Harvest (Tonnes Cha^{1})	Harvest Maturity cycle (yr)	Biomass accumulation rate (G) (tonnes Cha^{1} yr^{1})	Biomass carbon loss (L) (tonnes Cha^{1} yr^{1})	Error range[1]
Temperate (all moisture regimes)	63	30	2.1	63	+75%
Tropical, dry	9	5	1.8	9	+75%
Tropical, moist	21	8	2.6	21	+75%
Tropical, wet	50	5	10.0	50	+75%

Note: Values are derived from the literature survey and synthesis published by Schroeder (1994).
[1] Represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean.

TABLE 19: INFORMAL RECOMMENDATIONS ON BIOMASS OF WOODY CROPS (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 15	We recommend using references provided in 2019 IPCC refinement which are clearer and more detailed than 2006 IPCC guidelines.
Reco 16	We recommend dealing woody crops as a land use instead of a subcategory of cropland (if possible), it makes the calculations much easier.
Reco 17	We recommend being cautious by applying this method and not to forget losses when gains are applied on woody crops. With a constant area of woody crops gains should equal losses. Any large sink or source on these woody crops should be cautiously analyzed.

4.4.3. Calculation of carbon fluxes for conversions of land use

In the case of a land use conversion, equations 2.15 and 2.16 of the 2006 IPCC guidelines should be used. These equations merges two methods (carbon stock changes and Gains-losses).

This equation is presented for biomass but also possible for all pools.

Equation 8: Carbon fluxes on land with conversions (Equation 2.15, 2006 IPCC guidelines)

EQUATION 2.15
ANNUAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO OTHER LAND-USE CATEGORY (TIER 2)

$$\Delta C_B = \Delta C_G + \Delta C_{CONVERSION} - \Delta C_L$$

Where:

ΔC_B = annual change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}

ΔC_G = annual increase in carbon stocks in biomass due to growth on land converted to another land-use category, in tonnes C yr^{-1}

$\Delta C_{CONVERSION}$ = initial change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}

ΔC_L = annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category, in tonnes C yr^{-1}

Conversion to another land category may be associated with a change in biomass stocks, e.g., part of the biomass may be withdrawn through land clearing, restocking or other human-induced activities. These initial changes in carbon stocks in biomass ($\Delta C_{CONVERSION}$) are calculated with the use of Equation 2.16 as follows:

Equation 9: Carbon stock change between before and immediately after conversion (Equation 2.16, 2006 IPCC guidelines)

EQUATION 2.16
INITIAL CHANGE IN BIOMASS CARBON STOCKS ON LAND CONVERTED TO ANOTHER LAND CATEGORY

$$\Delta C_{CONVERSION} = \sum_i \{(B_{AFTER_i} - B_{BEFORE_i}) \bullet \Delta A_{TO\_OTHERS_i}\} \bullet CF$$

Where:

$\Delta C_{CONVERSION}$ = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1}

B_{AFTER_i} = biomass stocks on land type *i* immediately after the conversion, tonnes d.m. ha^{-1}

B_{BEFORE_i} = biomass stocks on land type *i* before the conversion, tonnes d.m. ha^{-1}

$\Delta A_{TO\_OTHERS_i}$ = area of land use *i* converted to another land-use category in a certain year, ha yr^{-1}

CF = carbon fraction of dry matter, tonne C (tonnes d.m.)$^{-1}$

i = type of land use converted to another land-use category

TABLE 20 : INFORMAL RECOMMENDATIONS ON CONVERSIONS (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 18	We recommend specifying explicitly the stocks of ligneous and non-ligneous biomass for land use conversions.
Reco 19	We don't 'recommend using the default values of 5tC/ha/yr from IPCC 2006 and 2019 for the gains after conversion to cropland (issue discussed among reviewers) even if it is what IPCC presents.
Reco 20	We recommend considering a gain of carbon for litter and deadwood for the conversion to forest and a loss of carbon for litter and deadwood for the conversion from forest based on default and country specific data of average stocks in forest.

4.4.4. Calculation of carbon fluxes in soil organic matter

For soils, the equation 2.25 of the 2006 IPCC guidelines allows to estimate carbon stock changes on the basis of changes in management (tillage intensity, fertilisation rate…).

It requires an efficient monitoring of practices to be considered as relevant enough. It should be applicable on cropland and grasslands. In practice it is very rare to collect relevant data in grassland management to implement such calculations.

For cropland, data on several management can be compiled and used to estimate the dynamics of carbon in soils.

Equation 10 : Carbon stock change in mineral soils (Equation 2.25, 2006 IPCC guidelines)

EQUATION 2.25
ANNUAL CHANGE IN ORGANIC CARBON STOCKS IN MINERAL SOILS

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REF_{c,s,i}} \bullet F_{LU_{c,s,i}} \bullet F_{MG_{c,s,i}} \bullet F_{I_{c,s,i}} \bullet A_{c,s,i} \right)$$

(Note: T is used in place of D in this equation if T is ≥ 20 years, see note below)

Where:

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

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

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

SOC_0 and $SOC_{(0-T)}$ are calculated using the SOC equation in the box where the reference carbon stocks and stock change factors are assigned according to the land-use and management activities and corresponding areas at each of the points in time (time = 0 and time = 0-T)

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

D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr. Commonly 20 years, but depends on assumptions made in computing the factors F_{LU}, F_{MG} and F_I. If T exceeds D, use the value for T to obtain an annual rate of change over the inventory time period (0-T years).

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

SOC_{REF} = the reference carbon stock, tonnes C ha^{-1} (Table 2.3)

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

[Note: F_{ND} is substituted for F_{LU} in forest soil C calculation to estimate the influence of natural disturbance regimes.

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

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

A = land area of the stratum being estimated, ha. All land in the stratum should have common biophysical conditions (i.e., climate and soil type) and management history over the inventory time period to be treated together for analytical purposes.

TABLE 21 : INFORMAL RECOMMENDATIONS ON SOILS (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 21	*We recommend being cautious when splitting the territory according to soils zones. All parameters should be estimated by zone. It may be better to simplify the work by using only one soil zone.*
Reco 22	*We recommend being aware of what is tracked by this methodology on soils. Only dynamics are captured by this method. It is worthless spending a lot of resources on soils if no data on dynamics are available.*
Reco 23	*We recommend focusing on intermediate crops, the use of residues, organic fertilization and tillage which are supposed to be the main drivers.*
Reco 24	*We recommend being careful on the effect of tillage which may be different according to the climate. We recommend using the references proposed in the 2019 refinement for soils.*
Reco 25	*We recommend being humble on our capacity to really track carbon changes in soils with IPCC methods, the uncertainty in the result is very high.*

4.4.5. Calculation of other emissions from soils

LULUCF is a sector that aims to track land carbon fluxes. Nevertheless, some land emissions have been associated with this sector, either because they were closely related to changes in carbon stocks or because they are associated with land use and not included in agriculture.

- N_2O emissions related to land fertilization (excluding agriculture)
- N_2O emissions related to soil carbon mineralization
- CO_2, CH_4, N_2O emissions related to management of organic soils
- Indirect N_2O emissions from soils at volatilization or leaching (excluding agriculture)

Different methods are presented to calculate these emissions, they are based on the amount of fertilizer, the area of cultivated organic soils, or the carbon losses from soils.

All these sources are usually minor sources compared to the rest of the inventory.

TABLE 22 : INFORMAL RECOMMENDATIONS ON OTHER EMISSIONS FROM SOILS (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 26	We recommend keeping these estimates simple (tier 1) considering the high uncertainty on these emissions.
Reco 27	We recommend focusing on organic soils if organic soils are significant and to use 2013 IPCC on wetlands for these sources.
Reco 28	We recommend being aware of what CO_2 emission from cultivation of organic soils mean: cultivation of organic soils leads to lower the watershed level. All carbon above the watershed level is exposed to oxidation and is emitted till another equilibrium is found. Under the watershed level, organic matter is protected from oxidation.

4.4.6. Calculation of emissions related to burning

Part of the emissions related to burning biomass is accounted for in the Agriculture sector (crop residue burning and savannah burning). There could still be biomass burning in the other land use categories, in particular under forestlands and grassland. These emissions are estimated with equation 2.27 of 2006 IPCC Guidelines.

Equation 11 : Emissions from biomass burning (Equation 2.27, 2006 IPCC guidelines)

EQUATION 2.27
ESTIMATION OF GREENHOUSE GAS EMISSIONS FROM FIRE

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} = amount of greenhouse gas emissions from fire, tonnes of each GHG e.g., CH_4, N_2O, etc.

A = area burnt, ha

M_B = mass of fuel available for combustion, tonnes ha^{-1}. This includes biomass, ground litter and dead wood. When Tier 1 methods are used then litter and dead wood pools are assumed zero, except where there is a land-use change (see Section 2.3.2.2).

C_f = combustion factor, dimensionless (default values in Table 2.6)

G_{ef} = emission factor, g kg^{-1} dry matter burnt (default values in Table 2.5)

Note: Where data for M_B and C_f are not available, a default value for the amount of fuel actually burnt (the product of M_B and C_f) can be used (Table 2.4) under Tier 1 methodology.

TABLE 23 : INFORMAL RECOMMENDATIONS ON BIOMASS BURNING (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 29	*We recommend being aware of what include the values of biomass provided by default in the guidelines. It may include both ligneous and non-ligneous biomass. And it may exclude trees in savannahs for instance. It does not include litter or soil organic matter in organic soils that may burn.*
Reco 30	*We recommend keeping default combustion factor and emission factor considering the high uncertainty of these parameters.*
Reco 31	*We recommend specifying the areas in land use change matrixes where areas are burnt to maintain the possibility to report emissions by land use category.*
Reco 32	*We recommend ensuring that there is no double counting of CO2 emissions with other carbon losses from biomass.*

4.4.7. Calculation of carbon fluxes due to harvested wood products (HWP)

A large share of the wood harvested remains in products for more than 1 year. Depending on the product, the lifetime can be short (paper…) or very long (50 or 100 years in buildings). The calculations can be made thanks to the equation 12.1 of the 2006 IPCC Guidelines.

Equation 12 : carbon stock changes in HWP (Equation 12.1, 2006 IPCC guidelines)

EQUATION 12.1

ESTIMATION OF CARBON STOCK AND ITS ANNUAL CHANGE IN HWP POOLS OF THE REPORTING COUNTRY

Starting with $i = 1900$ and continuing to present year, compute

$$(A) \qquad C(i+1) = e^{-k} \bullet C(i) + \left[\frac{\left(1-e^{-k}\right)}{k}\right] \bullet Inflow(i) \qquad with \;\; C(1900) = 0.0$$

$$(B) \qquad \Delta C(i) = C(i+1) - C(i)$$

Note: For an explanation of technique used in Equations 12.1A to estimate first-order decay see Pingoud and Wagner (2006).

Where:

i = year

$C(i)$ = the carbon stock of the HWP pool in the beginning of year i, Gg C

k = decay constant of first-order decay given in units, yr^{-1} ($k = \ln(2) / HL$, where HL is half-life of the HWP pool in years. A half-life is the number of years it takes to lose one-half of the material currently in the pool.)

$Inflow(i)$ = the inflow to the HWP pool during year i, Gg C yr^{-1}

$\Delta C(i)$ = carbon stock change of the HWP pool during year i, Gg C yr^{-1}

TABLE 24 : INFORMAL RECOMMENDATIONS ON HWP (NOT INCLUDED IN THE IPCC GUIDELINES)

Reco 33	*We recommend being cautious by applying this methodology and to ensure a complete timeseries since 1900 as expected by the guidelines to avoid any artificial discrepancy in reporting.*
Reco 34	*We recommend being fully aware of what this category recovers: stock variations of carbon in harvested products out of lands. Increasing stocks of harvested wood products should lead to sinks whereas decreasing stocks should lead to emissions. A constant use of wood should lead to an equilibrium between gains and losses.*
Reco 35	*We recommend making the calculations from IPCC equations to fully understand the method and possibly crosscheck with existing tools.*
Reco 36	*We recommend crosschecking statistics on harvest and statistics on sawn wood.*

ANNEX 1: TEMPLATE AND GUIDELINES FOR A MEMORANDUM OF UNDERSTANDING (MOU)

These guidelines and template are provided on the following link, it is based on USA examples:

https://www.doj.state.or.us/wp-content/uploads/2017/08/mou_sample_guidelines.pdf

It is recommended by 2019 IPCC refinement.

GUIDELINES FOR A MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) is required of an agency when an application for funds includes an explicit non-financial collaboration with partnering organizations. The MOU provides documentation that demonstrates the organizations have consulted and coordinated the responsibilities of their grant activities. The following elements should be considered when constructing an MOU:

- Describe each partner agency;
- State the purpose of the MOU;
- Clearly describe the agreed upon roles and responsibilities each organization or agency will be providing to ensure project success. The roles and responsibilities should align with project goals, objectives and target outputs;
- Identify the staff responsible for completing the specific responsibilities, this should include meeting CVSD reporting requirements;
- Describe how the collaboration/partnership benefits the project;
- Describe the resources each partner would contribute to the project. This can be contributing staff time, making in-kind contributions, delivering services, offering training or expertise, etc.;
- Provide a statement that the lead agency accepts full responsibility for the performance of the collaborative organizations/agencies; and
- The MOU must be signed by all partners. Signatories must be officially authorized to sign on behalf of the agency and include title and agency name.

SAMPLE FORMAT AND CONTENT MEMORANDUM OF UNDERSTANDING

All italicized sentences are considered instructions and should be deleted prior to the submission of the final MOU.

This Memorandum of Understanding (MOU) is entered into by and between: *Provide the agency name and a brief description of each agency*.

____

____

____

____

____

A. Purpose. *State the purpose of the MOU. Include statements that explain how the collaborative relationship enhances or benefits the Applicant's program;*

B. Roles and Responsibilities. *Clearly describe and delineate the agreed upon roles and responsibilities each organization or agency will be providing to ensure project success. The roles and responsibilities should align with project goals, objectives and target outputs. This may be contribution of staff time, in-kind contributions of space or materials, delivery of program services, provision of training or staff expertise, etc.*

Agency A agrees to:

Responsibility/Activity

Agency B agrees to:

Responsibility/Activity

C. Reporting Requirements. *Describe who will be responsible for collecting, collating and submitting data as per the project target outputs and outcomes.*

D. Timeframe. *Clearly state the time period that this MOU will be in effect.*

This MOU will commence on ___________________________ and will dissolve at the end of the grant funding period on _____________________________ .

F. Confidentiality. *In order to ensure the safety of clients, all parties to the Memorandum of Understanding agree to adhere to the confidentiality expectations as outlined in the Grant Agreement.*

The designated lead agency accepts full responsibility for the performance of the collaborative organizations/agencies.

This Memorandum of Understanding is the complete agreement between _____________________ and _____________________ and may be amended only by written agreement signed by each of the parties involved.

The MOU must be signed by all partners. Signatories must be officially authorized to sign on behalf of the agency and include title and agency name.

AGENCY A

Authorized Official: ____________________________ ______________________________________

Signature *Printed Name and Title*

Address: ____

Telephone(s): ____

E-Mail Address: ____

AGENCY B

Authorized Official: ____________________________ ______________________________________

Signature *Printed Name and Title*

Address: ____

Telephone(s): ____

E-Mail Address: ____

ANNEX 2: ADDITIONAL DETAIL FROM BENCHMARK ON LULUCF SYSTEMS IN EUROPEAN COUNTRIES

Note: information was collected for the NIR 2022, errors can occur for countries, especially for the estimate of people involved which are never explicitly mentioned.

Country	Political responsibility	Technical responsibility for GHG inventoriy	Technical responsibility for LULUCF	Estimate of number of people involved in LULUCF team
Austria	Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)	Federal Environment Agency (UBA)	Federal Environment Agency (UBA)	6
Belgium	Inter-ministerial conference for the environment (ICE)	Regional agencies	?	?
Bulgaria	Ministry of environment and water (MoEw)	Executive Environment Agency (ExEA)	Executive Environment Agen-cy (ExEA)	?
Croatia	?	EKONERG – Energy and Environmental Protection Institute	EKONERG – Energy and Environmental Protection Institute	2
Cyprus	Department of Environment of the Ministry of Agriculture, Rural Development and Environment (DoE)	Department of Environment of the Ministry of Agriculture, Rural Development and Environment (DoE)	Department of Environment of the Ministry of Agricul-ture, Rural Development and Environment (DoE)	1
Czechia	Ministry of the Environment (MoE)	Czech Hydrometeorological Institute (CHMI)	: Institute of forest ecosys-tem research (IFER), Global change research institute (GCRI)	5
Denmark	Ministry of Environment and Food and the Ministry of Climate, Energy and Utilities	Danish Centre for Environment and Energy (DCE)	Department of Geoscienc-es and Natural Resource Management, University of Copenhagen, Danish Centre for Food and Agriculture (DCA), Aarhus University	2
Estonia	Ministry of the Environment (MoE)	Estonian Environmental Research Centre (EERC)	Forest Department of the Estonian Environment Agency (EstEA)	4
Finland	?	Statistics Finland	Natural Resources Institute Finland (Luke)	5-6
France	Ministry of the Environment (MoE)	Citepa	Citepa	3

Country	Political responsibility	Technical responsibility for GHG inventoriy	Technical responsibility for LULUCF	Estimate of number of people involved in LULUCF team
Hungary	Ministry of agriculture	HMS (unit of national emission inventories)	Hungarian National Land Centre (NLC), Forestry Department of the NLC, Forest Research Institute of the University of Sopron, National Food Chain Safety Office (NFCSO)	3
Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (leadership)	federal environment Agency (UBA)	Thünen Institute (TI)	>10
Greece	Division of Climate Change and Air Quality of Ministry of environment and energy (MEEN)	National Technical University of Athens (NTUA) / School of Chemical Engineering	National Technical University of Athens (NTUA)	?
Italy	Ministry for the Environment, Land and Sea	Institute for Environmental Protection and Research (ISPRA)	Institute for Environmental Protection and Research (ISPRA)	2
Iceland	Ministry of the Environment Energy and Climate	Environment Agency	Soil Conservation Service of Iceland, Icelandic Forest Service	4
Ireland	?	?	?	1
Latvia	Ministry of Environmental protection and regional development	Latvian Environment, Geology and meteorology Center	Latvian State Forest Research Institute (LSFRI) «Silava»	4
Lithuania	Ministry of Environment	Environment protection agency	Lithuanian Research Center for Agriculture and Forestry, State Forest Service	3
Luxembourg	Ministry for the Environment, Climate and Sustainable Development (MECDD)	Environment Agency	Environment Agency	1
Netherlands	?	?	Wageningen university and research	1
Norway	?	Norwegian Environment Agency	Norwegian Institute of Bio-economy Research	7
Poland	Minister of Climate and Environment	National Centre for Emissions Management (KOBiZE) in the Institute of Environmental Protection	National Centre for Emissions Management (KOBiZE) in the Institute of Environmental Protection	?
Portugal	Agency of environment protection (APA)	APA´s Climate Change Department (DCLIMA)	APA´s Climate Change Department (DCLIMA)	1
Romania	Ministry of Environment (MEWF)	Environmental Protection Agency (NEPA)	ICSI, INCDS, ICPA, INCAS	>10
Slovakia	Ministry of Environment (MŽP SR)	Slovak Hydrometeorological Institute (SHMÚ)	National Forest center Zvolen, research institute on soil protection, National agriculture and food institute	6

Country	Political responsibility	Technical responsibility for GHG inventoriy	Technical responsibility for LULUCF	Estimate of number of people involved in LULUCF team
Slovenia	Ministry of the Environment and spatial planning	Slovenian Environment Agency (SEA)	Slovenian Forestry Institute, Agricultural Institute of Slovenia	2
Spain	Dirección General de Calidad y Evaluación Ambiental del MITECO	Unidad de Inventario de Emisiones de la Subdirección General de Aire Limpio y Sostenibilidad Industrial de la DGCEA(UI) & assisted by: sociedad TRAGSATEC (Ttsec)	Unidad de Inventario de Emisiones de la Subdirección General de Aire Limpio y Sostenibilidad Industrial de la DGCEA(UI) & assisted by: sociedad TRAGSATEC (Ttsec)	3
Sweden	Ministry of the Environment	Swedish Environmental Protection Agency (Swedish EPA)	Swedish University of Agricultural Sciences (as consultants)	7

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