Natural carbon sinks in Belgium by 2050 and beyond

Definition of scenarios and assessment of potential

Study accomplished under the authority of
Federal Public Service Public Health - Environment
February 2026

SYTRA transition of food systems

LIÈGE université Gembloux Agro-Bio Tech

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SUMMARY

Belgium's ability to meet climate goals requires not only large emission reductions across all sectors but also a strategic enhancement of natural carbon sinks. Today, the Land Use, Land Use Change and Forestry (LULUCF) sector offsets a limited share of national greenhouse gas (GHG) emissions, accounting for only about 0.4% of total national GHG emissions in 2022, with forests providing the majority of removals while cropland and grassland act as net sources. Strengthening these sinks is essential to compensate for residual emissions that will remain even after ambitious mitigation efforts.

This study, commissioned by the Federal Public Service Health, Food Chain Safety and Environment, assesses the potential of Belgium's natural carbon sinks by 2050 and beyond. It evaluates how land use changes, agricultural practices, forest management, and wetland restoration could contribute to increasing carbon sequestration, improving resilience, and safeguarding biodiversity. The core objective is to define actionable strategies for enhancing Belgium's carbon sink capacity while safeguarding biodiversity, emphasizing that strengthening natural sinks is complementary to, not a substitute for, emission reductions at the source across all sectors.

Three land-use scenarios form the backbone of the assessment:

1. **Reference scenario**: continues historical trends, projecting further expansion of settlement areas and loss of grassland, while forest and cropland remain largely stables. Carbon sinks remain approximately at the same level assuming a limited uptake of agroforestry, and show a decline without the removals of agroforestry.
2. **Current policy scenario**: incorporates existing and planned regional measures, including afforestation in Flanders, protection of grassland areas, and reductions in urbanization through spatial planning reforms. These measures moderately strengthen carbon sequestration.
3. **Major change scenario:** explores a transformative pathway inspired by climate-neutrality scenarios at EU-level. It assumes substantial dietary shifts and reductions in livestock production, freeing land for biodiversity restoration, afforestation, wetland restoration, and the expansion of protein crop production. Agricultural systems become more extensive, grasslands are preserved, peatlands are rewetted, and urban land take is halted by 2030. This scenario delivers the largest increase in carbon removals while also improving biodiversity and climate resilience.

The study includes detailed assessments of:

- **Agriculture**, analyzing production systems, organic farming expansion, land use allocation, and the emissions implications of shifting to more extensive and diversified systems.
- **Forests**, evaluating current carbon stocks, biodiversity status, management practices, vulnerabilities, and how each scenario would influence future sequestration and ecosystem health.
- **Wetlands and peatlands**, compiling available data on extent, degradation, and restoration potential, and quantifying emissions reductions achievable through rewetting and conservation.

The analysis suggests that for Belgium to effectively optimize its natural carbon sinks, a shift beyond incremental policies is necessary. The Reference Scenario, which continues current trajectories, does not entail a significant increase in carbon sinks and leads to declining sinks without the uptake of agroforestry. Although the Current policy Scenario, by incorporating existing measures, stabilizes and moderately improves the sink, it may not be sufficient to

meet the full ambition required by long-term climate goals. The Major Change Scenario emerges as the pathway with the highest potential to deliver long-term climate benefits. This scenario is effective because it combines two essential levers for climate action in the land sector. On the one hand, it includes a substantial enhancement of carbon removals, mostly driven by widespread afforestation and supported by a change in agricultural management practices. In addition, it concurrently delivers the most pronounced reduction in overall agricultural greenhouse gas emissions by promoting a more sustainable, plant-based food system.

The potential of Belgium's carbon sink capacity is closely linked to the evolution of its food and land-use system. The transition toward reduced reliance on intensive livestock farming plays a crucial enabling role by freeing up land that can then be strategically allocated to nature-based climate mitigation.

The consolidated results show that while current and planned policy measures can slow or reverse the decline in natural sinks, only transformative land use changes, particularly in the agricultural sector, enable substantial carbon sequestration gains aligned with long-term climate goals. Enhancing natural sinks must be pursued in parallel with emission cuts, strategic spatial planning, and ecosystem-based management across Belgium's landscapes.

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LIST OF ACRONYMS

CA	Conservation Agriculture
DOC	Dissolved Organic Carbon
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
NIR	National Inventory Report
SOC	Soil Organic Carbon
UAA	Utilised Agricultural Area

1 INTRODUCTION

1.1 Context and definitions

With the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement an international, legally binding agreement was reached to act against climate change and limit global warming to 1.5°C (UNFCCC, 2016). Under this agreement, all Parties are required to regularly report their greenhouse gas (GHG) emissions and removals to ensure transparency and track progress toward their climate commitments. This reporting is done through National Inventory Reports (NIRs), comprehensive, standardized reports that quantify emissions and removals across five sectors: energy, industrial processes and product use, agriculture, waste, and the land use, land-use change and forestry (LULUCF) sector. These inventories follow the methodological guidelines established by the Intergovernmental Panel on Climate Change (IPCC) (UNFCCC, 2016; IPCC, 2006).

The European Union has translated the UNFCCC Paris agreement into an ambitious framework, set out in the European Climate Law, to reduce emissions by 55% by 2030, compared to 1990 levels, and to reach climate neutrality by 2050. To achieve these targets the EU has established a comprehensive climate policy built around three pillars: the EU Emissions Trading System (ETS), the Effort Sharing Regulation (ESR), and the Land Use, Land Use Change and Forestry Regulation. The ETS[1] regulates emissions from large industrial installations and the energy sector through a cap-and-trade system, while the ESR[2] sets binding national targets for sectors not covered by the ETS, such as transport, buildings, agriculture, and waste. The LULUCF sector, in turn, accounts for greenhouse gas (GHG) emissions and removals resulting from land use, land use change, and forestry activities. It reflects how human activities influence carbon pools, such as living biomass, dead organic matter, and soil organic carbon. When carbon is removed from the atmosphere and stored in these pools, the process is referred to as carbon removal or sequestration. Ecosystems where sequestration exceeds emissions function as carbon sinks, helping to offset GHG emissions from other sectors. Conversely, when land is degraded or converted, these same carbon pools can become sources of emissions. Carbon storage or stock can be defined as the amount of carbon stored in a carbon pool (European Environment Agency, 2024; European Parliament and the Council of the European Union, 2018). The LULUCF sector holds unique potential for simultaneous climate mitigation, biodiversity protection, and resource provisioning. Notably, the IPCC identifies mitigation in forest ecosystems, carbon sequestration in agriculture, and large-scale ecosystem restoration as the most impactful land-based strategies (United Nations Climate Change, n.d.).

While the enhancement of carbon sinks in the LULUCF sector is an essential component of the EU's climate strategy, the primary pathway to achieving climate neutrality remains the substantial reduction of emissions at their source. Natural carbon sinks can only compensate for a limited share of residual emissions and do not have the capacity to offset current emission levels. In Belgium, this limitation is particularly evident: according to the 2024 National Inventory Report, the net sink of the LULUCF sector in 2022 accounted for only about 0.4% of total national GHG emissions. Forests are the largest CO_2 sink in Belgium with a reduction of -1988 kt CO_2eq (see Table 4 of the NIR by CELINE-IRCEL et al. (2024)). Since the 2020 update of soil carbon stock data, grasslands are no longer reported as carbon sink, resulting in an emission of 317 kt CO_2eq. Cropland has been an increasing net source of emissions

[1] https://climate.ec.europa.eu/eu-action/carbon-markets/eu-emissions-trading-system-eu-ets_en
[2] https://climate.ec.europa.eu/eu-action/effort-sharing-member-states-emission-targets/about-effort-sharing_en

since 1990. As a result, overall net removals from the LULUCF sector in Belgium have declined significantly (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Strengthening and protecting these sinks is therefore complementary to, but certainly not a substitute for, ongoing emission reduction efforts across the energy, industry, transport, and agricultural sectors. The challenge ahead thus lies in striking the right balance between emission reductions and the sustainable enhancement of natural carbon sinks to achieve long-term climate neutrality.

As part of the LULUCF Regulation, binding targets for each member state were established to ensure that the land sector contributes to climate neutrality by protecting and enhancing natural carbon sinks. For the period 2021–2025, Member States must ensure that accounted emissions do not exceed removals (the “no-debit rule”). For the period 2026–2030, national targets are established as part of a collective EU goal of 310 Mt CO_2eq net removals by 2030, with individual targets tailored to each country’s capacity and historical performance. Belgium’s national target for 2030 amounts to an additional net removal of -320 kt CO_2eq (European Parliament and the Council of the European Union, 2023).

Within the framework of international and European commitments, Belgium must contribute to the EU climate neutrality goal, both by reducing emissions on the one hand, but also by increasing the natural carbon sinks. In Belgium, both regional and federal administrations play a pivotal role in achieving the emission reductions set out in the European framework. The federal level holds responsibility in several key policy domains, including fiscal policy, rail transport within mobility, and offshore wind development, the energy transmission network, nuclear energy and biofuels in the energy domain. The federal level also oversees reporting obligations to European entities and helps to coordinate the climate transition at the national level. The regional administrations are responsible to define and implement climate mitigation and adaptation measures at the regional level, for instance through land use planning and agricultural policy – policy domains which can form a lever for enhancing carbon sinks in the LULUCF sector. The Belgian NIR is consolidated annually based on data from the Walloon, Flemish and Brussels Capital Regions. Given the relations between federal and regional levels in Belgium, effective climate action requires collaboration, knowledge exchange and burden sharing among administrations. Close collaboration is necessary to ensure an effective approach to reduce emissions and eventually reach climate neutrality.

To operationalize the transition to climate neutrality, the federal administration has drawn up a vision document with the intention to contribute to the long-term strategy (FPS Health, DG Environment, Climate Change Section, 2020). This document develops a vision for the different greenhouse gas (GHG) emitting sectors, identifying policy levers and strategic workstreams, where further collaboration with stakeholders is needed to reach climate neutrality. Within the context of this vision several possible scenarios were developed to reach climate neutrality in Belgium by 2050. These scenarios explore possible pathways towards reaching climate neutrality in Belgium by 2050 (FPS Public Health, DG Environment, Climate Change Section, 2021). However, even when GHG emissions are significantly reduced, residual emissions will remain. To achieve climate neutrality, it is therefore necessary to invest in both emission reductions and carbon sequestration. The latter can be achieved through technical solutions or through the protection, optimization and restoration of natural carbon sinks in land.

Greenhouse gases trap heat in the atmosphere and thus contribute to global warming through their positive radiative forcing effect. Under the UNFCCC, Parties are required to report emissions and removals of seven direct GHGs (Table 1): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The Global Warming Potential (GWP) quantifies how much a greenhouse gas contributes to global warming over a specific period relative to CO_2, enabling comparison and aggregation of different gases' climate impacts. To enable comparison and aggregation, emissions of all GHGs are reported in carbon dioxide equivalents (CO_2eq), a standardized metric obtained by multiplying the amount of each gas by its respective GWP value *(IPCC, 2014; CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024)*. In addition, NIRs also include information on indirect GHGs, such as carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), and sulfur dioxide (SO_2) (Table 1). While these gases are not counted in the total GWP-weighted emissions, they are reported because they influence the atmospheric concentrations of direct GHGs or act as ozone precursors, thereby indirectly affecting climate processes *(Gillenwater, et al., 2006)*.

Within the LULUCF sector, the principal greenhouse gases of concern are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). CO_2 emissions and removals arise mainly from changes in carbon stocks in biomass and soils, CH_4 is primarily released from wetlands and drained organic soils, and N_2O emissions result from soil processes such as nitrification and denitrification linked to land management practices (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). To compare the climate impact of different greenhouse gases relative to CO_2 over a specific time horizon the IPCC developed the Global Warming Potential (GWP). It expresses the cumulative radiative forcing, i.e. the total energy absorbed in the atmosphere, caused by a given mass of a gas compared to the same mass of CO_2. The 100-year GWP values reported in the IPCC Fifth Assessment Report (AR5) are commonly used for greenhouse gas inventories, with a GWP of 28 for CH_4 and 265 for N_2O (IPCC, 2014). These values allow emissions of different gases to be expressed on a common scale as CO_2 equivalents (CO_2eq), facilitating aggregation and comparison across sources and sectors.

Table 1: Direct and indirect GHGs covered in the Belgian GHG inventory (source: (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024; Gillenwater, et al., 2006))

Type	GHGs	Comments
Direct GHGs	- Carbon dioxide (CO2) - Methane (CH4) - Nitrous oxide (N2O) - Hydrofluorocarbons (HFCs) - Perfluorocarbons (PFCs) - Sulphur hexafluoride (SF6) - Nitrogen trifluoride (NF3)	Contribute directly to climate change due to their positive radiative forcing effect.
Indirect GHGs	- Nitrogen oxides (reported as NO_2) - Carbon monoxide (CO) - Non-Methane Volatile Organic Compounds (NMVOCs) - Sulfur oxides (reported as SO_2)	Impact indirectly direct GHGs and/or are ozone precursors.

1.2 Objectives of the study

This study aims to explore the potential of natural carbon sinks and storage in Belgium by focusing on both land use change scenarios and land management practices. It seeks to delineate actionable strategies for enhancing Belgium's carbon sink capacity, while safeguarding biodiversity and ecosystem functioning. While strengthening natural sinks represents a crucial element of climate mitigation, it is again emphasized that their primary role lies in compensating for residual emissions rather than offsetting current emission levels. Therefore, the activation of carbon sequestration potential should be seen as complementary to, and not a substitute for, emission reductions at the source across all sectors.

To achieve this aim, the study builds on ongoing collaborative efforts between federal and regional entities, leveraging interdisciplinary expertise to advance integrated pathways toward Belgium's long-term climate objectives.

1.3 Outline of the study

This study consists of four main parts: the development of land use scenarios, and specific analyses on agriculture, forest, and additional analyses on wetlands and peatlands. Based on the results of these four main parts are consolidated in part 5 (Figure 1).

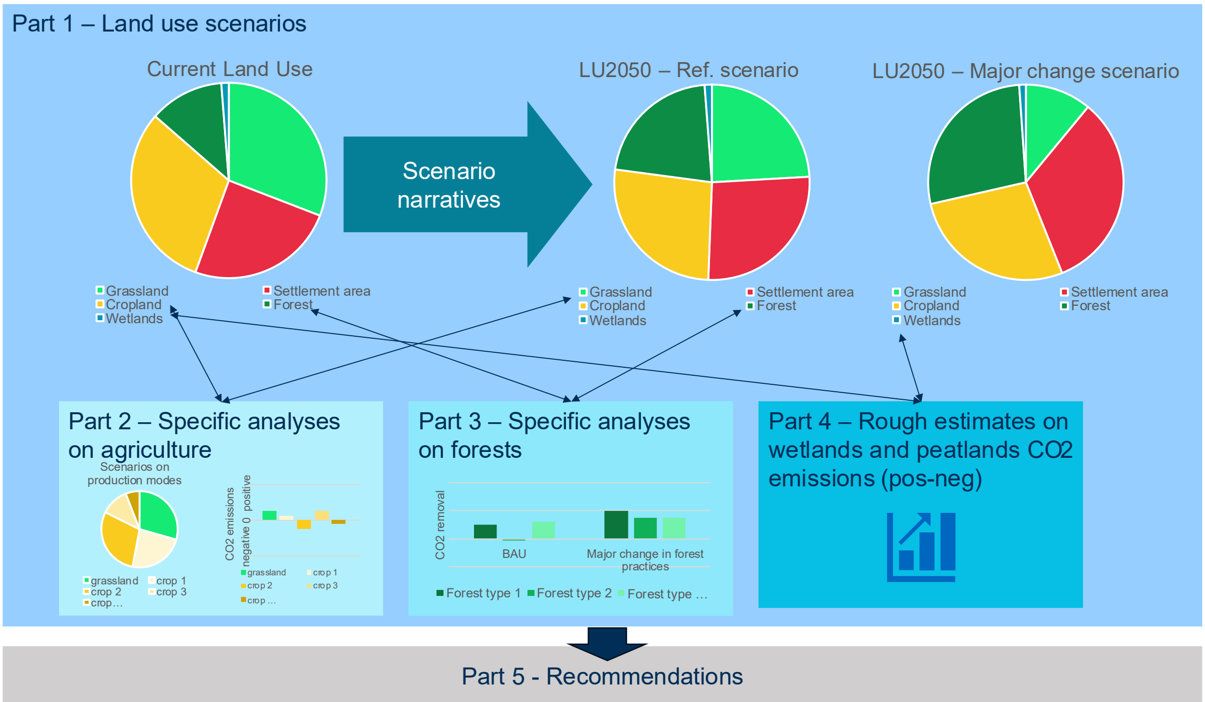

Figure 1: Overview of the outline of the study: land use scenarios are developed, with multiple feedback links to the specific analyses of agriculture, forest, and wetlands and peatlands.

Three different future land use change scenarios are developed:

- A reference scenario based on an extrapolation of historical trends in land use change
- A current policy scenario based on regional measures to enhance natural carbon sinks
- A scenario with major changes in future land use

The narratives of these land use change scenarios were validated in a stakeholder workshop. Future areas of the five main land use categories (forest, cropland, grassland, wetlands and settlement area (Table 2)) are subsequently quantified for all three scenarios.

These scenarios are combined with specific analyses on agriculture, forest, and wetlands. The specific analysis on **agriculture** *(Part 2 – Specific analysis on Agriculture*) focuses on describing the diversity of crops that are included in the generic category of 'agriculture' (§3.3 – *Action 1: Document the diversity of the existing modes of production in Belgium*). Considering the importance and relevance of grassland to carbon sinks in the agricultural sector, permanent grassland will be included in this analysis. The modes of production are summarized in typologies for each sector, ranging from 'most intensive' to 'most extensive' production mode (§3.4 – *Action 2: Define the use of production*). The impacts of these systems on agricultural production, GHG emissions and removals, and biodiversity are then quantified for the three land use change scenarios (§3.5 – *Action 3: Document the impact of the production systems – Scenario Results*).

The analysis of **forests** (*Part 3 – Specific analysis on Forests*) includes an assessment of current forest distribution, composition and management practices (§4.1 – *Belgian Forest Distribution, Composition, Tenure and Management Practices*). An overview of current carbon stocks (§4.2 – *Current Carbon Stocks*) and fluxes (§4.3 – *Current Carbon Sequestration* Rates) is provided, which is extrapolated to assess the impact of the land use change scenarios on carbon absorptions (§4.3.5). Other factors influencing carbon sequestration, including species composition and disturbance regimes are described in §4.4 – *Other Factors Influencing Carbon Sequestration*. The feasibility of forest carbon enhancement is discussed in §4.5 – *Feasibility of Forest Carbon Sequestration Enhancement*, while §4.6 – *Co-Benefits of Forest Carbon Enhancement* provides an overview of potential co-benefits of forest carbon enhancement. The analysis on forests is concluded in §4.7 – *Synthesis, Conclusion and* .

In comparison to agriculture and forest, less data is available on carbon sinks in wetlands in Belgium. The aim of the specific analysis on **wetlands** (*Part 4 – Additional* analysis on wetland) is therefore to gather data and expertise on the occurrence (surface area and state) (§5.1 – *Wetland and peatland extent in Belgium*), together with possible conservation and restoration measures (§5.2 – *Wetland and peatland restoration*) and an estimate of potential (positive or negative) GHG emissions (§5.3 – *Emissions from wetlands and peatlands*).

The specific analyses on these three land use types are combined with the three land use change scenarios to quantify the impact on future CO_2 emissions and removals. An overview of the results and key messages of each analysis is presented in *Part 5 - Consolidation and conclusion*.

2 PART 1: LAND USE SCENARIOS

Land use in the LULUCF sector is categorized into five main types: forest, cropland, grassland, wetlands and settlement area. This classification corresponds with the land use categories defined by the IPCC (International Panel on Climate Change, 2019) and applied in Belgium's National Inventory Report (NIR) of greenhouse gas emissions under the UNFCCC framework. These land use types, and their corresponding definitions, are provided in Table 2. In this context, grassland contains (semi-)natural, recreational and permanent grasslands, whereas temporary grasslands, i.e. grassland that is maintained for a limited period as part of a crop rotation system, are categorized as cropland. The area shares of current land use in Belgium according to the NIR are provided in Figure 2 (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Table 2: Five main categories of land use and their corresponding definitions, corresponding to the classification of land use by the IPCC (International Panel on Climate Change, 2019).

Forest	*"This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category."*
Cropland	*"This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category."*
Grassland	*"This category includes rangelands and pastures that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions."*
Wetlands	*"This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions."*
Settlement Area	*"This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions."*

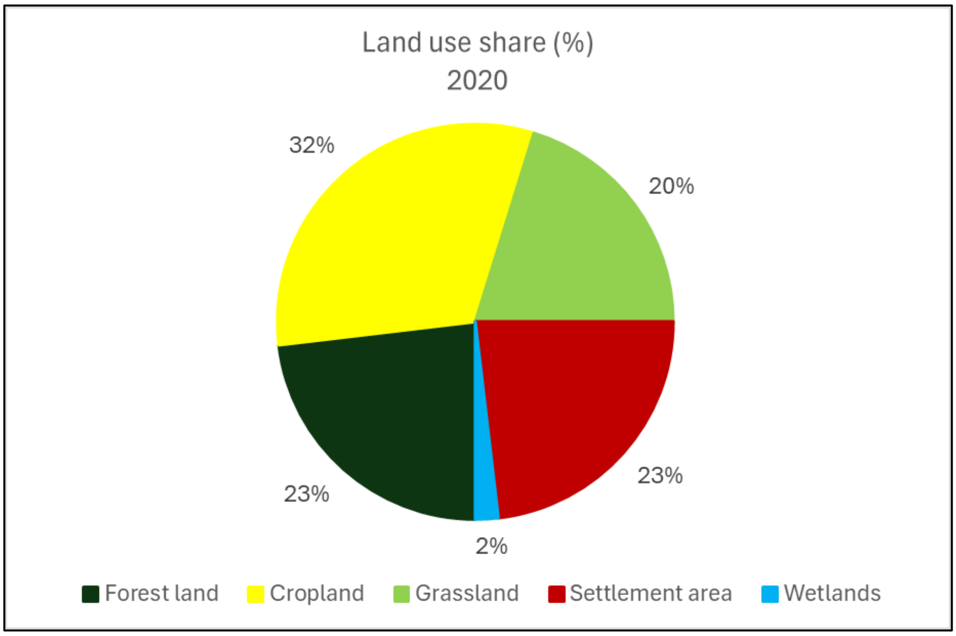

Figure 2: Current shares (%) of forest land, cropland, grassland, wetland and settlement area as reported in the NIR of Belgium (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Three land use scenarios have been developed to estimate land use patterns by 2050, each based on a distinct narrative:

- **Reference** scenario: this business-as-usual land use scenario extrapolates historical and current trends in land use change and management practices.
- **Current policy** scenario: this scenario incorporates the implementation of existing and planned policies influencing carbon sinks through changes in land use and management practices. This current policy scenario is based on measures included in the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios, which are reported in the context of international climate targets (National Climate Commission, 2024).
- **Major Change** scenario: this transformative scenario assumes a significant departure from historical trends. It is more ambitious than the current policy scenario in its aim to enhance natural carbon sinks while safeguarding biodiversity and ecosystem functioning.

For each of these scenarios, land use areas in 2050 are quantified. To ensure consistent historical data on land use and land use change, the land use data from Belgium's NIR is used as the basis for the land use change scenarios. These projected land use areas, and associated land use changes and management practices, serve as the basis for estimating potential future carbon emissions.

2.1 Methodology

2.1.1 Reference scenario

The reference land use scenario for 2050 is based on an extrapolation of historical trends of land use change in Belgium as reported in the NIR. Land use changes in the NIR are assessed using the Land Use Change (LUC) matrix, which consists of a grid of reference points where land use is identified for various years through the interpretation of orthophotos and thematic cartographic layers. Each point represents an area of approx. 200 ha. A linear inter- and extrapolation is then applied to estimate land use changes between the years for which the LUC matrix is available. As such, land use and land use change data are available between 1990 and 2022 (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). These data are used in a linear regression to extrapolate the land use changes to 2050.

2.1.2 Current policy scenario

To track progress toward climate goals in the Paris Agreement (UNFCCC, 2015) and the European LULUCF regulation (European Parliament and the Council of the European Union, 2018) countries must report projected emissions under WEM (With Existing Measures) and WAM (With Additional Measures) scenarios. The WEM scenario is based on implemented policies, while the WAM scenario also incorporates planned policies, which are on the policy agenda.

The regional authorities in Belgium are responsible for the definition and implementation of climate mitigation measures. Several policies have been implemented or are planned to increase carbon sequestration in land. However, not all these policies can be adequately quantified within the context of greenhouse gas emissions reporting. As a result, only a selection of measures is included in the WEM and WAM prognosis outlined in the first Biennial Transparency Report (BTR) of Belgium to the UNFCC. In the Brussel-Capital Region land use is kept constant for the projected period in BTR (National Climate Commission, 2024).
An overview is compiled of policy measures affecting carbon sequestration in land use for both Flanders (Table 3) and Wallonia (Table 4). These measures can have an influence on either land use changes or land management practices. Based on the reference scenario, land use in 2050 is then adjusted to account for the anticipated impacts of the policy measures included WEM and WAM policy scenarios. As only one WAM measure impacts projected land use change (the ‘Bouwshift’ restricting urban development in Flanders), one policy land use change scenario is put forward representing current regional policies in Belgium (detailed in §2.2.2).

*Table 3: Overview for **Flanders** of policy measures included in the BTR (National Climate Commission, 2024), updated with recent information from the Flemish Energy and Climate Plan (Vlaams Energie- en Klimaatplan; VEKP) (Vlaamse Regering, 2023).*

Action/measure	Policy	Scenario
Forest		
Forest compensation – no net deforestation	Bosuitbreiding 2030	WEM
Afforestation of 10 000 ha	'Meer bos voor Vlaanderen'	WEM
Cropland		
Conservation of carbon storage in arable land (cropland)	Common Agricultural Policy (GLB)	WEM
Increase carbon storage on 100 000 ha of cropland	Common Agricultural Policy (GLB) – promotion of certain management practices (e.g., application of compost, stable manure or wood chips) and adjusted cropping plans	WEM
Grassland		
Protection of grassland	Common Agricultural Policy (GLB) / Soil erosion mitigation	WEM
Increase of permanent grassland with 2000 ha	Common Agricultural Policy (GLB)	WEM
Wetlands/peatlands		
Protection of (agricultural) peatland and wetlands	Common Agricultural Policy (GLB) – policy framework peat protection (beleidskader veenbescherming)	WAM
Restoration of 20 000 ha wetlands (natte natuur') by 2030	Blue Deal – Program 'Natte Natuur'	WEM
Settlement area		
Bouwshift – reduce urbanization/artificialization of soils (3 ha by 2025 and 0 ha by 2040)	'Bouwshift' (Departement Omgeving, 2024)	WAM
Increase blue-green infrastructure in settlement area	Climate Adaptation Plan, Local Energy and Climate Pact (Lokaal Energie- en Klimaatpact; LEKP)	WEM

*Table 4: Overview of **Wallonia** of policy measures included in the BTR (National Climate Commission, 2024) and additional measures taken from the Plan Air Climat Energie (PACE) 2030 de la Wallonie (Gouvernement Wallon, 2023).*

Action/measure	Policy	Scenario
Forest		
Resilient forests: encouraging public and private forest managers to diversify species and adapt them to climate change while promoting sustainable practices (e.g., uneven-aged forestry, natural regeneration)	Plan de Relance de la Wallonie (PRW), Stratégie Forestière Régionale (Filière Bois Wallonie, 2024)	WEM
Consider subsidizing the conversion of coniferous to deciduous stands	Programme Wallon de développement rural (PwDR)	WAM
Cropland		
Preserve existing hedgerows and wooded strips in agricultural land and promote the plantation of additional features	Common Agricultural Policy (PAC)	WEM
Yes we plant!: increasing green landscape features by planting 4000 km hedges and 1 million trees	Plan ‘Yes we plant’ (Service public de Wallonie, 2024)	WEM
Grassland		
Improvement and maintenance of organic carbon in soils – trends in soil organic carbon (for cropland and grassland) will remain constant from 2030 onwards	Common Agricultural Policy (PAC) (MAEC sol)	WEM
Preserve permanent grasslands, promoting the extensive use of these grasslands and maintaining them in good agronomic and environmental condition – Land use change from grassland to cropland will stop from 2025	Common Agricultural Policy (PAC)	WEM
Wetlands/peatlands		
Protect peat soils and poorly drained soils (class ‘g’ in soil map of Belgium) and permanent grasslands in areas of high flood risk (prohibition on plowing, drainage and modifying the soil topography)	Common Agricultural Policy (PAC)	WEM
Settlements		
Decrease urbanization (the conversion to settlement area) gradually to 0 ha by 2050	Schéma de Développement du Territoire (SDT) (SPW TLPE: SPW Territoire, 2024)	WEM

2.1.3 Major change scenario

A scenario describing major land use change is defined, representing a clear departure from historical trends and going beyond the level of ambition put forward in the WAM scenario of the regional authorities. To inform this scenario, several existing scenario studies and policy frameworks were examined to identify potential drivers and measures capable of supporting transformative changes in land use with a view to maximizing natural carbon sinks, while safeguarding biodiversity and ecosystem functioning. An overview of this review can be found in Annex 2. The main measures regarding LULUCF, recurring across several scenarios and policy frameworks, are:

- **Afforestation and sustainable forest management**: Afforestation contributes to an increased carbon storage in biomass. Sustainable forest management practices that enhance carbon sequestration while maintaining productivity include selective logging, extended rotation periods, natural regeneration, deadwood retention and the establishment of mixed species plantations (ETC-CA, 2022).
- **Rewetting of peatlands:** rewetting drained peatlands is highly effective for reducing greenhouse gas emissions by restoring the natural hydrology and thereby reducing or halting carbon loss.
- **Preservation and restoration of grasslands:** Conserving existing permanent grassland and restoring degraded grassland through extensive management can enhance soil carbon stocks and promote biodiversity (Verma, et al., 2025) (Conant, et al., 2017).
- **Sustainable agricultural management:** Practices such as carbon farming – entailing also the inclusion of semi-natural, woody landscape features such as hedgerows, tree lines, agroforestry and woodlots – aim to improve soil health, increase soil organic matter content, and sequester carbon, while contributing to more resilient and biodiverse agroecosystems.

As main inspiration for major change scenario, the study by Agora on climate neutral agriculture, forestry and food in the EU is used (Agora Agriculture, 2024). This scenario was developed in a comprehensive way, detailing the transition of the agricultural, forestry and food sector to climate neutrality, while maintaining food security, enhancing biodiversity and supporting the bioeconomy. By using this European scenario as inspiration, the major change scenario can be positioned within a broader European context.

A workshop was organized to validate the scenario of Agora within the Belgian context and further refine with a particular focus on land use allocation and region-specific considerations. This process involved expert stakeholders from the different regions of Belgium, bringing together expertise in agriculture, extensification, forestry, sustainable bioenergy and biomass, greenhouse gas inventories, and carbon sequestration to ensure the scenario's relevance, feasibility, and integration with regional land use dynamics and policy frameworks. An overview of participants and the notes of this workshop can be found in Annex 1.

The major change scenario is subsequently detailed using insights from the workshop discussions, as well as a review of studies and available data regarding, among others, agriculture, trade, food consumption, housing, peatlands, and forestry in Belgium. While the scenario integrates available evidence and expert input, the underlying figures remain subject to uncertainty and should be regarded as approximations intended to support reflection and dialogue on long-term land use transitions, rather than as detailed or prescriptive projections.

The land use change scenarios are based on land use data reported in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). However, for the major change scenario (§2.2.3), data from the

Belgian statistical office Statbel is used to quantify the impact of measures on agricultural areas. A discrepancy exists between the NIR and Statbel agricultural land use data: the NIR reflects actual land cover, while Statbel includes only land used for professional agriculture, as registered in the Crossroad Bank for Enterprises (Agentschap Landbouw en Zeevisserij, 2024). As a result, Statbel tends to underestimate total agricultural land, and cropland area reported in the NIR exceeds that in Statbel. Nonetheless, because Statbel provides the most detailed data at the Belgian level and the measures in the major change scenario are expected to primarily affect professional agriculture, Statbel data is used to estimate land use changes in agricultural areas for the major change scenario.

2.2 Results

An overview of the land use categories for all scenarios can be found in §2.2.4, Table 11.

2.2.1 Reference scenario

Land use in 2050 in the reference scenario is derived from the areas of land use changes between 1990 and 2022 as reported in the NIR. The trends from this period are extrapolated to 2050 using a linear regression (Figure 3). These trends show a decrease in grassland and an increase in settlement area. All current land management practices are assumed to continue until 2050. Flanders currently has around 1.6% of its agricultural land under organic farming (Bonte & Leys, 2023), up from approx. 0.9% in 2015 (Agentschap Landbouw en Zeevisserij, 2024). In Wallonia, about 13% of agricultural area is used for organic farming (See Part 2 – Agriculture) compared to 8.8% in 2015 (SPW Environnement, 2017). Extrapolating from these trends suggests organic farming could reach around 4% in Flanders and 19% in Wallonia by 2050. The share of agricultural land devoted to biodiversity area is kept at the current level of 4.15% (see also §2.2.3.3) (European Environment Agency, 2024).

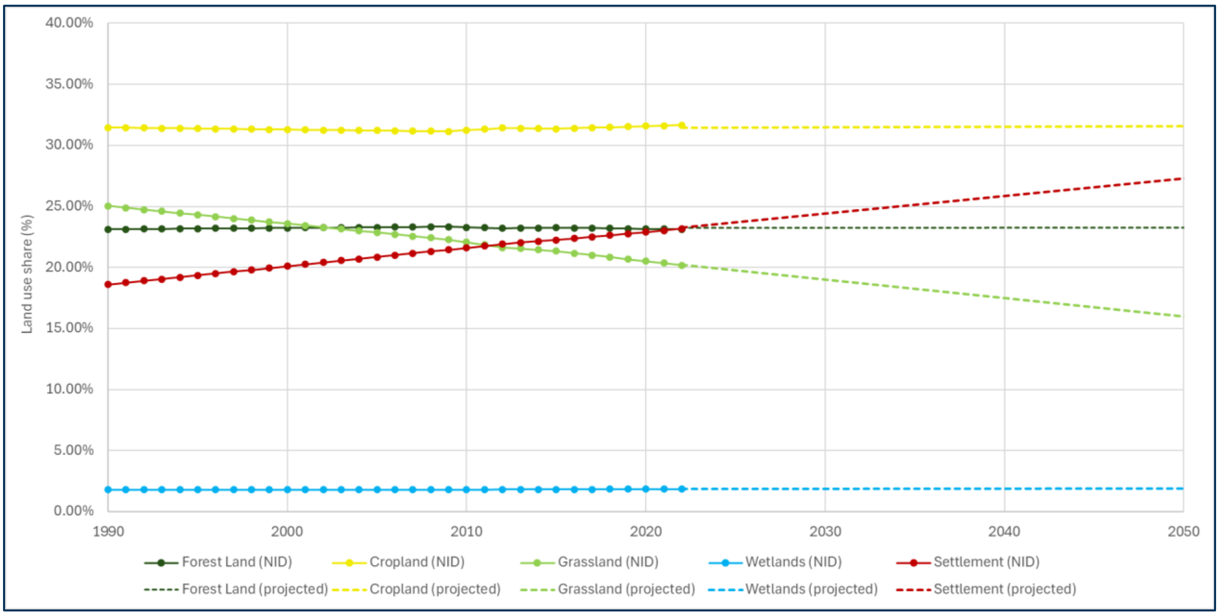

Figure 3: Extrapolation of land use share (%) to 2050 based on land use and land use change areas reported in the NIR of Belgium (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Figure 4 provides the area shares of land use in 2050 according to the trend extrapolation of land use change trends reported in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). These main land use categories are further detailed in Table 5 and illustrated in Figure 4 and Figure 5. Compared to current land use, settlement area increases from a land share of 23% to 27%, while grassland decreases from a land share of 20% to 16%. The area of forest land, wetlands and cropland remain unchanged.

Trends in livestock numbers are also linearly extrapolated to 2050 based on Statbel data from 2005 to 2022 (see also §2.2.3.1). The number of dairy cows remains approximately stable, showing a slight decrease of around 1%. The herd of bovine animals (including suckler cows and veal calves) is projected to decline by about 51%. The number of pigs is expected to decrease by roughly 8%. In contrast, the number of poultry and laying hens increases significantly, by approximately 83% and 42% respectively.

Table 5: Areas for the main land use and land use change categories in 2020 and 2050 corresponding to the reference scenario based on a linear extrapolation of land use data of the NIR of Belgium (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Figure 5 illustrates these land uses and land use changes.

	Area 2022 (ha)	Area 2050 (ha)	
Cropland	**972 000 ha**	**976 000 ha**	**+4000 ha**
Cropland remaining cropland		864 000 ha	
Forest land to cropland		*2000 ha*	
Grassland to cropland		*109 000 ha*	
Grassland	**620 000 ha**	**490 000 ha**	**-130 000 ha**
Grassland remaining grassland		415 000 ha	
Forest to grassland		*10 000 ha*	
Cropland to grassland		*64 000 ha*	
Forest land	**710 000 ha**	**710 000 ha**	**-**
Forest land remaining forest land		686 000 ha	
Cropland to forest land		*3000 ha*	
Grassland to forest land		*20 000 ha*	
Settlement area	**711 000 ha**	**835 000 ha**	**+124 000 ha**
Settlement area remaining settlement area		712 000 ha	
Forest land to settlement area		*10 000 ha*	
Cropland to settlement area		*42 000 ha*	
Grassland to settlement area		*70 000 ha*	
Wetland	**57 000 ha**	**58 000 ha**	**-**

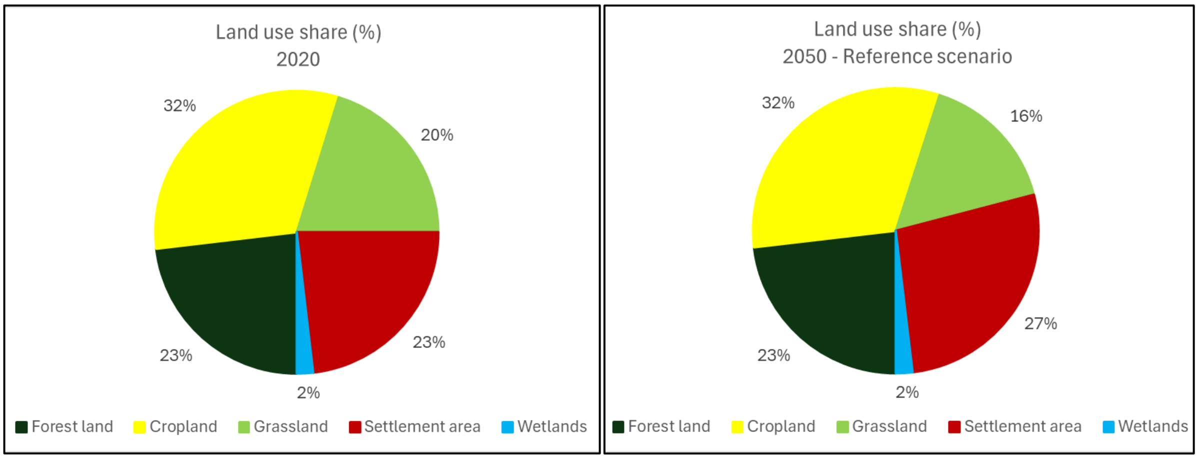

Figure 4: Current land use shares (%) (left) and projected shares (right) of forest land, cropland, grassland, wetland and settlement area in 2050, derived from trend extrapolation from land use changes reported in the NIR of Belgium (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

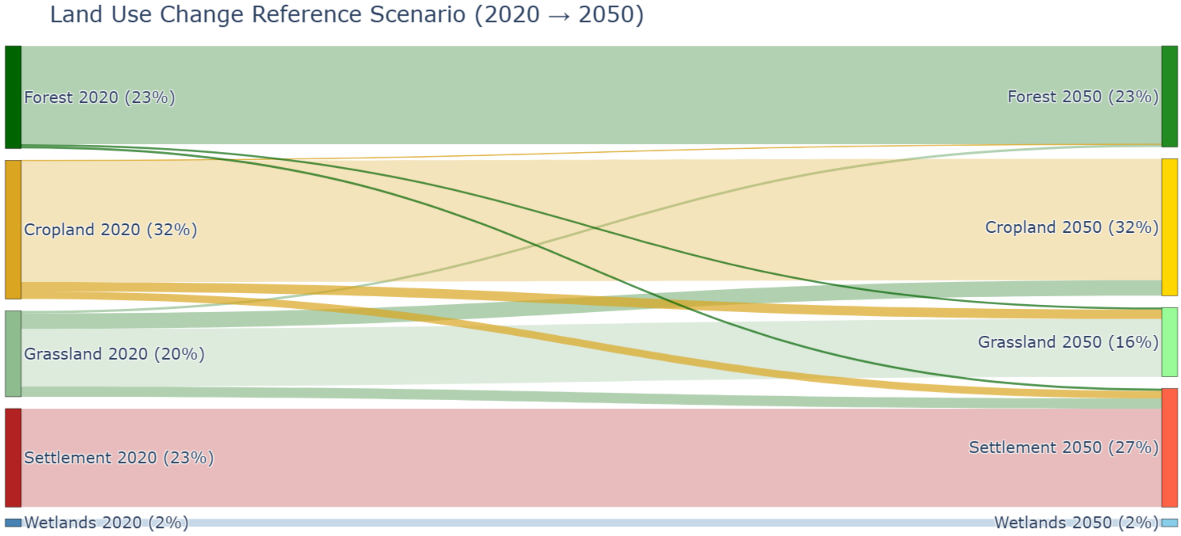

Figure 5: Illustration of the main land use changes according to the reference scenario between 2020 and 2050.

2.2.2 Current policy scenario

The current policy scenario incorporates existing and planned measures from Flanders and Wallonia, in Table 3 and Table 4. Given that only one WAM-measure – the '*Bouwshift*' in Flanders reducing artificialization of land – could impact land use in 2050, one current policy scenario regarding land use change is composed, including the following measures:

- An increase of 10 000 ha of forest in Flanders: this increase in forest land was distributed between cropland (15%) and grassland (85%) according to the land use change distribution of afforestation recorded in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).
- An increase of 2000 ha of grassland in Flanders: under the Common Agricultural Policy (CAP), farmers receive subsidies to convert temporary grassland, which is classified as cropland, into permanent grassland.

- No conversion from grassland to cropland from 2025 onwards in Wallonia: assuming 65% of grasslands are situated in Wallonia, the conversion from cropland to grassland for 65% of the area in the reference scenario in this category – a total of approx. 56 000 ha after 2025 – thus remains grassland in the current policy scenario.

- Decrease in urbanization in both regions: a reduction to 0 ha by 2050 in Wallonia, assuming a further artificialization of 12 000 ha, and a decrease in urbanization rate to 3 ha per day by 2025 and 0 ha by 2040 in Flanders, assuming a further artificialization of 16 400 ha. By limiting the further artificialization of land to 28 400 ha by 2050, approx. 95 000 ha of urbanization is avoided in comparison to the reference scenario, of which 54 000 ha grassland, 8000 ha forest land and 33 000 ha cropland.

The areas of the reference scenario for 2050 are adjusted accordingly to the policy measures included in the current policy scenario. The resulting land use area shares are illustrated in Figure 6 and Figure 7.

With regards to agricultural management practices, Flanders aims to increase its share of organic farming to 5% of agricultural land by 2027 (Bonte & Leys, 2023). If the same trend continues, a share of 16.5% would be reached by 2050 in Flanders. Wallonia aims to achieve a 30% share of organic farming by 2030, thereby exceeding the ambition of 25% by 2030 put forward in the EU Green Deal and incorporated in the EU Biodiversity strategy for 2030 (European Commission, 2020). Continuing the same trend, this would lead to a share of 57% of organic farming by 2050 in Wallonia. The share of agricultural land allocated to biodiversity is kept at the current level of 4.15% (European Environment Agency, 2024) (see also §2.2.3.3).

For this current policy scenario, the same trends in livestock numbers were assumed as in the reference scenario, except for pig production. While the reference scenario projects an 8% reduction in the pig population by 2050 based on historical trends, the *Stikstofdecreet* adopted by the Flemish Government in December 2023 sets a more ambitious target: a 30% reduction by 2030, primarily through voluntary cessation schemes with financial compensation (Vlaams Parlement, 2023). Given that approximately 95% of pig production is located in Flanders (see also §2.2.3.1), a national reduction of 30% is assumed in the current policy scenario.

Table 6: Adjustments to land use by 2050 according to the cuurent policy measures included in the current policy scenario (based on regional WEM/WAM measures outlined in Table 3 and Table 4) compared to the reference scenario.

Land use category	Measure	Area change (ha)	Area by 2050 (ha)
Grassland			**593 000 ha**
Grassland remaining grassland	*No conversion from grassland to cropland from 2025 onwards*	+56 000 ha	517 000 ha
Grassland remaining grassland	*Avoided urbanization*	+54 000 ha	
Cropland to grassland	*Conversion of 2000 ha of cropland to permanent grassland (temporary grassland conversion)*	+2000 ha	66 000 ha
Forest land			**728 000 ha**
Forest land remaining forest land	*Avoided urbanization*	+8000 ha	694 000 ha
Cropland to forest land	*+10 000 ha forest (in Flanders)*	+1500 ha	5000 ha
Grassland to forest land	*+10 000 ha forest (in Flanders)*	+8500 ha	29 000 ha
Cropland			**949 000 ha**
Cropland remaining cropland	*Avoided urbanization*	+33 000 ha	894 000 ha
Cropland remaining cropland	*+10 000 ha forest (in Flanders)*	-1500 ha	
Cropland remaining cropland	*Conversion of 2000 ha of cropland to permanent grassland (temporary grassland conversion)*	-2000 ha	
Grassland to cropland	*No conversion from grassland to cropland from 2025 onwards*	-56 000 ha	53 000 ha
Settlement area			**739 000 ha**
Settlement area remaining settlement area			712 000 ha
Forest land to settlement area	*Avoided urbanization*	-8000 ha	2000 ha
Cropland to settlement area	*Avoided urbanization*	-33 000 ha	9000 ha
Grassland to settlement area	*Avoided urbanization*	-54 000 ha	16 000 ha

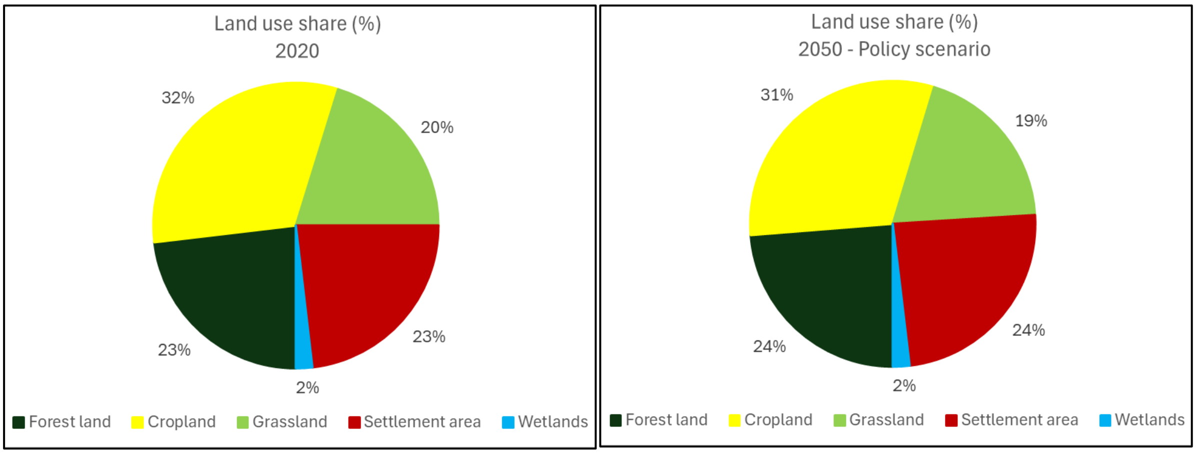

Figure 6: Current land use shares (%) (left) and projected shares (right) of forest land, cropland, grassland, wetland and settlement area in 2050, implementing current WEM/WAM policy measures with an impact on land use distribution.

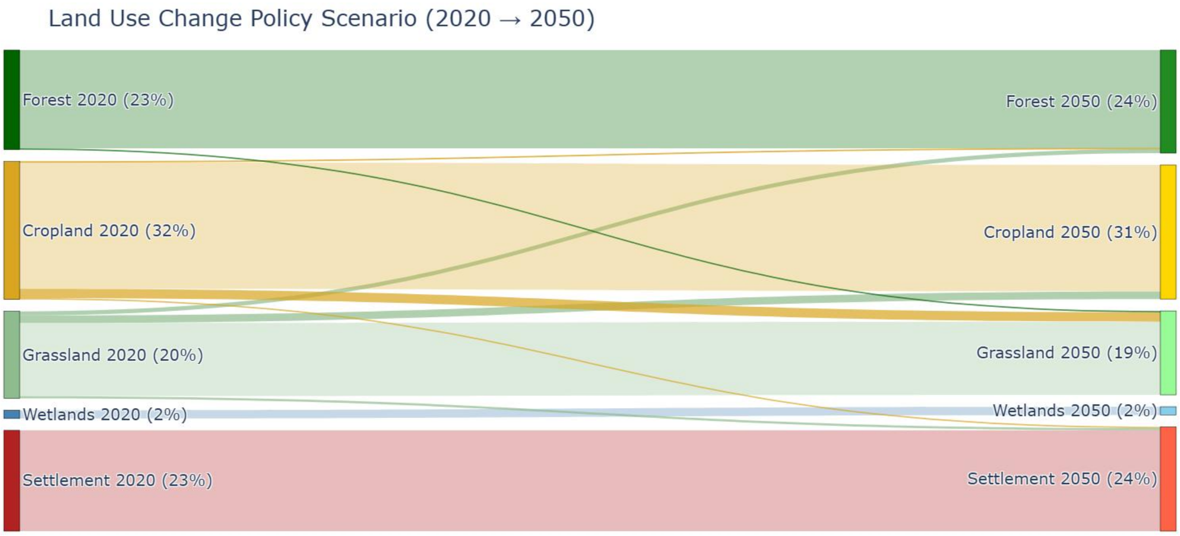

Figure 7: Illustration of the main land use changes according to the current policy scenario between 2020 and 2050.

2.2.3 Major change scenario

The major change scenario marks a clear shift from current trends, aiming to maximize carbon sinks while enhancing biodiversity and ecosystem functioning, and balancing trade-offs with objectives like food self-sufficiency, sustainable agriculture, and supporting the bioeconomy.

Based on a review of scenarios and policy frameworks, the study by Agora on agriculture, forestry and food in a climate neutral EU was selected as starting point to build the major land use change scenario. This scenario was developed in a comprehensive way, detailing the transition of the agricultural, forestry and food sector to contribute to climate neutrality, while maintaining food security, enhancing biodiversity and supporting the bioeconomy. The Agora scenario has a time horizon of 2045, by which agricultural emissions are reduced by over 60% compared to 2020 levels, while carbon removals are significantly increased. Agora considers the results of the 2045 scenario also applicable to the time horizon of 2050, allowing an additional five years for implementation (Agora Agriculture, 2024). By using this scenario as inspiration, we can position the major change scenario within a broader European context. The measures described in the Agora scenario (with an impact on carbon sequestration) are translated to a Belgian context. The main driver of land use changes in the major change scenario is a reduction in livestock production (§2.2.3.1), leading to less feed and forage production, allowing this cropland to be allocated to other land uses. Although livestock production is reduced, grassland is maintained through a shift toward more extensive production systems (§2.2.3.4). More agricultural area is allocated to biodiversity (§2.2.3.3) and the share of organic farming is increased, to 40% of agricultural land in Flanders and 60% in Wallonia.

The overall narrative of the major change scenario is outlined below, while the context and quantification of land use changes is provided in the following sections.

To address global challenges such as climate change and loss of biodiversity, Belgium embarks on a transformative path in land use and land management. Systemic shifts driven by dietary changes, spatial planning reforms, and enhanced ecosystem resilience aim to reshape land use to foster a more sustainable, climate-resilient future.
A roadmap was drawn up to guide the necessary land-use changes and accompanying policies to enable them, directing land use based upon its potential to optimally contribute to the overall and multifaceted goal of maximizing natural carbon sinks and enhancing biodiversity, while acknowledging trade-offs with self-sufficiency for food and feed, sustainable agriculture and supporting the bioeconomy.
One of the core catalysts for achieving a more sustainable, multifunctional land use was the transition to more sustainable animal farming. Animal farming occupies a significant amount of land to provide the necessary feed, and much of its production was destined for export. As governments across Europe set up schemes incentivizing dietary changes among their populations, healthier, more plant-based diets became more widely adopted. European livestock production in meat correspondingly decreased. As a result, intensive livestock breeding in Belgium was reduced, easing environmental pressures and freeing up a substantial share of cropland previously used for feed and forage to be repurposed for other uses (§2.2.3.1).
Sustainable agricultural management practices were promoted to increase carbon sequestration and enhance biodiversity. Woody landscape features were established with this multifunctional goal in mind (§2.2.3.3). Domestic production of protein-rich crops was expanded (§2.2.3.2), as was well as the production of fiber and other industrial crops. As livestock numbers decreased, it became feasible for local sustainable soybean production to meet the demand for feed (§2.2.3.7.1), allowing for the reduction of soybean import that bring with it biodiversity loss through deforestation and greenhouse gases.

Despite the number of livestock decreasing, efforts were made to preserve grasslands (§2.2.3.4), recognizing their value for biodiversity as well as their potential as carbon sinks. Extensive grazing practices were adopted, fostering more biodiversity-rich pastures.
Drained agriculture peatlands were restored, with cropland converted into shallow-drained grasslands and grasslands being restored to wetland areas (§2.2.3.5). Despite the significant cost, settlements in prone regions, such as river valleys, were returned to natural wetlands, enhancing both climate resilience and biodiversity (§2.2.3.6.2). Paludiculture was implemented in regions where temporarily flooded areas were developed.
Thanks to considerable efforts of regional authorities artificialization of land was halted by 2030, twenty years ahead of the European Union's no-net land take. After 2030, the encroachment of urban areas in (semi-)natural or rural land after 2030 was prevented through efficient and sustainable urban development and densification, thereby incorporating green-blue infrastructure (§2.2.3.6).
Gradually, and with sustained effort, forest area in Belgium was expanded. Afforestation efforts were primarily focused in Flanders, incorporating integrated land use planning to create a visually appealing and biodiverse agriculture-forest mosaic. All forested land, both new and existing, was managed sustainably, promoting the natural regeneration of diverse tree species at varying ages. Resilient stands were established across the country, enhancing the forests' ability to withstand the impacts of climate change. Forests remained productive, supporting timber production and sustainable wood harvests, while efforts were made to stabilize the demand of wood through the promotion of a circular economy (§2.2.3.7).
To achieve this, a phased program was established, considering optimal successions of land use and integrated land use planning that maximized synergies between climate change mitigation, adaptation, biodiversity, and landscape quality.

2.2.3.1 Reduction in livestock production

Livestock production in Belgium is mostly concentrated in Flanders, especially regarding pork and poultry production (Figure 8). Approximately 95% of pig production and 84% of poultry production in Belgium is concentrated in Flanders. In recent years, the pig population has been declining, partly due to measures implemented under the Programmatic Approach to Nitrogen (*Programmatische Aanpak Stikstof*, PAS), which have created uncertainty about the continuation of farming operations. Additionally, the *Stikstofdecreet* adopted by the Flemish government in December 2023 sets the ambition to reduce the pig population by 30% by 2030, primarily through voluntary cessation schemes with financial compensation (Vlaams Parlement, 2023). The bovine herd is more evenly distributed between Flanders and Wallonia, although approximately 60% of dairy cows are located in Flanders. Between 2010 and 2022, the dairy cow population has shown a slight increase. Poultry and laying hen numbers have also been rising, with poultry production in Flanders growing by 75% between 2005 and 2022. In contrast, the increase in Wallonia has been less pronounced (Statbel, 2025).

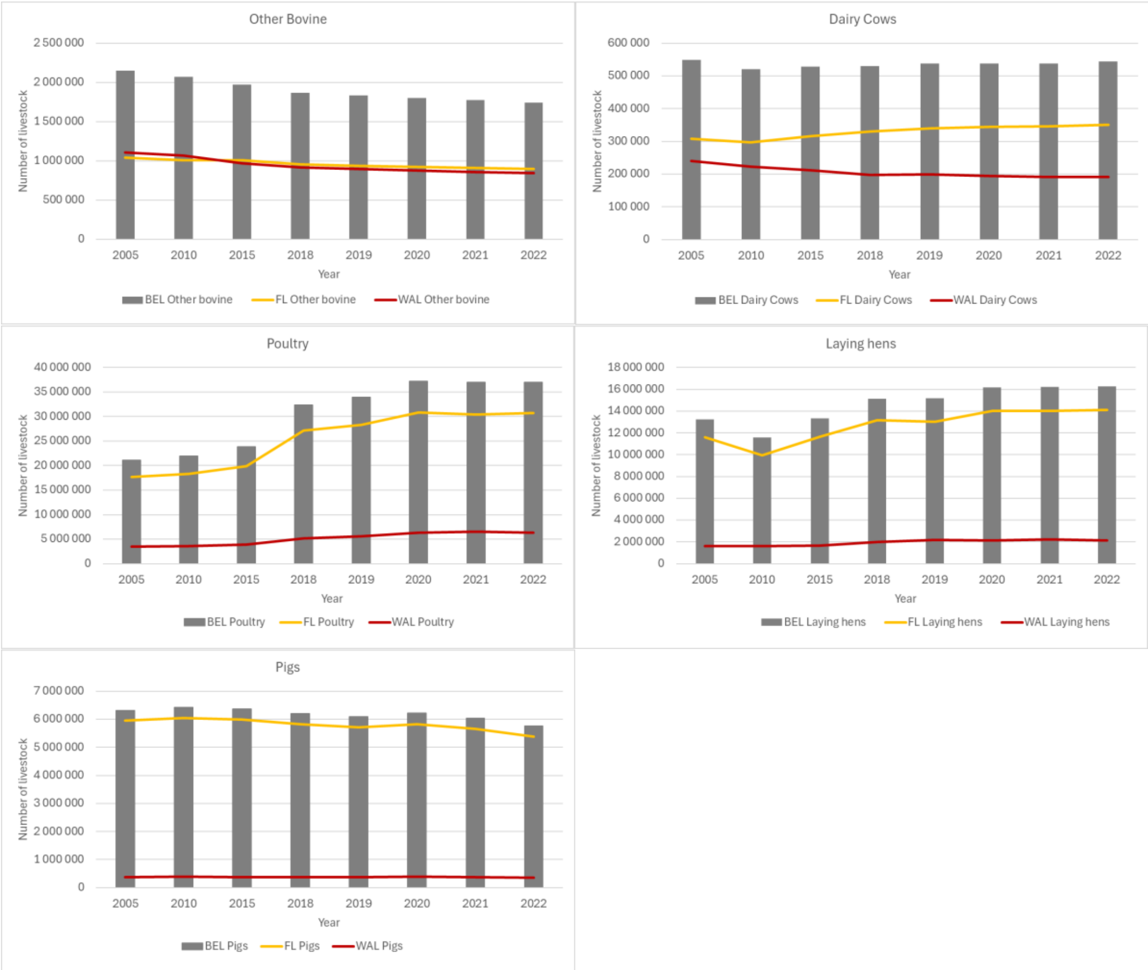

Figure 8: Livestock production in Belgium, partitioned into Flanders and Wallonia. Other bovine is defined as the total bovine herd minus dairy cows. (Statbel, 2025).

Livestock reduction is an important feature in several scenarios aiming at climate neutrality, including the European scenario of Agora for agriculture, forestry and food (Agora Agriculture, 2024), in the French transition scenarios of ADEME (Agence de la transition écologique) (ADEME, 2021) and in the Dutch scenarios on climate neutral agriculture (PBL, 2024). Reduction in livestock production has a two-fold impact: on one hand, emissions in the agricultural sector decrease due to reduced livestock-related emissions; on the other hand, land previously used for feed crops becomes available for alternative land uses capturing more carbon.

One possible driver to reduce livestock production is **dietary change**, more specifically a reduction in EU-wide meat consumption. The scenario proposed by Agora projects a shift in European diets from animal-based proteins to more plant-based proteins based on the Planetary Health Diet (PHD), developed by the EAT-Lancet Commission (Willett, et al., 2019). The PHD proposes a flexitarian eating pattern, promoting both human health and environmental sustainability. It emphasizes the consumption of vegetables, fruits, whole grains, legumes, nuts, and oils rich in unsaturated fats, while allowing low to moderate amounts of fish, seafood, and poultry. It limits the consumption of red or processed meat, added sugars, dairy, and starchy vegetables like potatoes.

Recognizing that dietary transitions require time, Agora assumes an adherence of 80% to the PHD and 20% to current European consumption patterns for the average European diet by 2045. As a result of this dietary change, the Agora scenario projects an average reduction of 51% in meat consumption by 2045, with a decrease of 60% in beef consumption, 67% in pork consumption, and 18% in poultry consumption. Dairy and egg consumption decrease with resp. 43% and 42%. This results in a protein shift, transitioning from a diet composed of 30% plant-based and 70% animal-based protein to one with 62% plant-based and 38% animal-based protein. These figures are based on the protein content of the average EU food consumption (Agora Agriculture, 2024). In comparison, Belgium average protein intake in 2014 consisted of 35% plant-based protein and 65% animal-based protein (Riera, et al., 2019).

This diet was also compared to other dietary guidelines for healthy diets with reduced environmental impacts to ensure consistency and alignment. With respects to the recommendations of the Superior Health Counsil (*Hoge Gezondheidsraad/Conseil Supérieur de la Santé*) of 2019, the proposed diet aligns well. The Council recommends a maximum intake of 300 g of red meat (i.e., beef and pork) per week, which corresponds to approx. 43 g per day. The Agora diet assumes a daily meat consumption of 73 g, of which approx. 36 g of beef and pork, thus staying within the recommended limit. For milk consumption, the Council recommends an intake between 250 and 500 ml per day, while the Agora diet assumes an average of 367 g/day, which falls comfortably within the advised range. At present, consumption of pulses and plant-based proteins remains low in Belgium, the recommendations of the Council thus highlight the need to encourage their uptake to diversify protein sources, recommending at least one portion (150 g) of pulses per week. The Agora diet projects a daily consumption of 90 g of legumes (peas, soy, beans and lentils) by 2045, thus exceeding the minimum recommendation set by the Superior Health Council (Hoge Gezondheidsraad/Conseil Supérieur de la Santé, 2019) (Agora Agriculture, 2024).

The dietary transition scenario proposed by Agora is thus largely in line with dietary recommendations, including those of the Belgian Superior Health Council, while also contributing to the reduction of environmental impacts. The level of dietary change included in the Agora scenario can be considered ambitious. For comparison, the European Commission's LIFE scenario, developed as part of its impact assessment of the 2040 climate target for the EU, presents a more moderate transition. It includes a gradual shift in EU food demand toward the Planetary Health Diet (PHD), reaching 25% adherence by 2040, to illustrate the potential of demand-side measures alongside supply-side climate action (European Commission, 2024). Against this backdrop, the dietary transformation envisioned in the Agora scenario – reaching 80% adherence to the PHD by 2045 – represents a major shift in consumption patterns. An analysis of food consumption surveys from 2004 and 2014 shows that meat consumption in Belgium declined by approximately 6%, dairy consumption decreased by around 10%, while egg consumption remained stable over this period (De Ridder, et al., 2016). If these trends were linearly extrapolated to 2050, they would result in a 21% reduction in meat and a 35% reduction in milk consumption. The dietary change proposed in the major change scenario – a reduction of 51% and 43% in resp. meat and milk consumption – therefore also goes beyond current trends observed in Belgium, underscoring its ambition and transformative potential in shifting consumption patterns.

The reduction in livestock production is influenced not only by meat consumption, but also by the competitiveness of EU production in international markets. According to Agora, the EU has a comparative advantage in dairy production due to abundant grasslands, therefore dairy production will decrease less than dairy consumption, allowing for an increase in exports. In contrast, the decline in consumption of pork and poultry is reflected in a similar decrease in production, due to high international competition. As such, pig production undergoes the biggest decline (64% – 70%). Cattle production decreases by 52% (71% for beef, 45% for dairy cows). Poultry production decreases by 28%. As most Belgian meat and dairy production is largely export-oriented (see below), and given that most Belgian meat trade occurs within Europe, a European-wide decline in meat consumption, as proposed by Agora, would directly affect the Belgian export market. Therefore, the assumptions outlined in the scenario of Agora are considered applicable to Belgium, where similar trends in livestock production are expected to occur (Table 7).

Another potential driver for reducing livestock production is a decline in **meat exports**. Belgium has a theoretical self-sufficiency ratio (production vs. consumption) of around 132% for beef, 224% for pork and 222% for poultry (averaging figures for 2021, 2022 and 2023), indicating that domestic supply exceeds domestic demand, especially for pork and poultry. The last available figures regarding theoretical self-sufficiency for dairy products show that in 2012 the theoretical self-sufficiency rate for milk products was 145%, while for eggs, it was 109% in 2013 (Statbel, 2024). Livestock production in Belgium is thus largely export-oriented. Meat and edible meat offal exports from Belgium totaled $3.98 billion in 2023, which constitutes approximately 1% of total Belgian exports (TrendEconomy, 2025). The international trade of meat products to and from Belgium is primarily concentrated within Europe, with additional trade regions including Asia and Africa (Riera, et al., 2019) (ITC, 2025) (Figure 9). Belgian export of dairy produce totaled $5.12 billion in 2023, constituting 1.3% of total Belgian export (TrendEconomy, 2025). For eggs, approximately 44% of exports went to the Netherlands in 2023. The export market for milk is more diverse, but the main sales markets are the Netherlands, France, and Germany (Figure 10).
If production were to be adjusted to meet only the demands of the internal Belgian market – assuming a theoretical self-sufficiency of approx. 100% – this would lead to a decrease of 24% for bovine meat production, 55% for pork and poultry production, and 31% for milk production (Statbel, 2024) (Statbel, 2025). For egg production, no decline is assumed as the latest figures (from 2013) suggest a self-sufficiency ratio nearing 100% (109%).

Comparing the impact of dietary change and a reduction of production levels to meet domestic demand for meat and dairy, livestock production is lowest in the pathway involving a decrease in EU-wide meat consumption. This pathway also brings significant additional benefits, including the promotion of sustainable food consumption patterns and the adoption of healthier diets, contributing to long-term sustainability and public health objectives. Given that most Belgian livestock exports are destined for the European market, a decline in EU demand would also significantly affect Belgium's export volumes. Therefore, the pathway of dietary change proposed by the Agora scenario by 2045 is adopted in the major change scenario by 2050, allowing five additional years compared to Agora's timeline to achieve this more transformative dietary transition (Agora Agriculture, 2024). This shift is not merely adopted as a strategy for self-sufficiency, but as a catalyst for systemic transformation. Supporting policies are required to drive change on both the supply and demand side of the agri-food system. On the supply side, this can include measures to support a managed reduction in livestock numbers through targeted incentives, transition support for farmers, and repurposing of subsidies. In Flanders, such measures are currently implemented in a limited capacity, primarily through voluntary cessation schemes for pig farmers, where financial compensation is provided to support a reduction in production (Vlaams Parlement, 2023). On the demand side, policies can raise awareness of dietary impacts, and encourage healthier and more climate-aligned consumption patterns.

Table 7: Reduction in livestock production for pork, broilers, laying hens, dairy cows and bovine animals between 2022 and 2050. The number of animals in 2022 is based on Statbel data for the year 2022 for Flanders and Wallonia, rounded to the nearest hundred (Statbel, 2025).

	Livestock numbers (2022)	Reduction in production levels	Livestock numbers 2050
Pork	5 751 200	-70%	1 725 400
Broilers	37 033 800	-28%	26 664 300
Laying hens	16 249 000	-28%	11 699 300
Dairy cows	543 400	-45%	298 900
Bovine[1]	496 600	-71%	144 000

[1]Bovine: suckler cows + veal calves

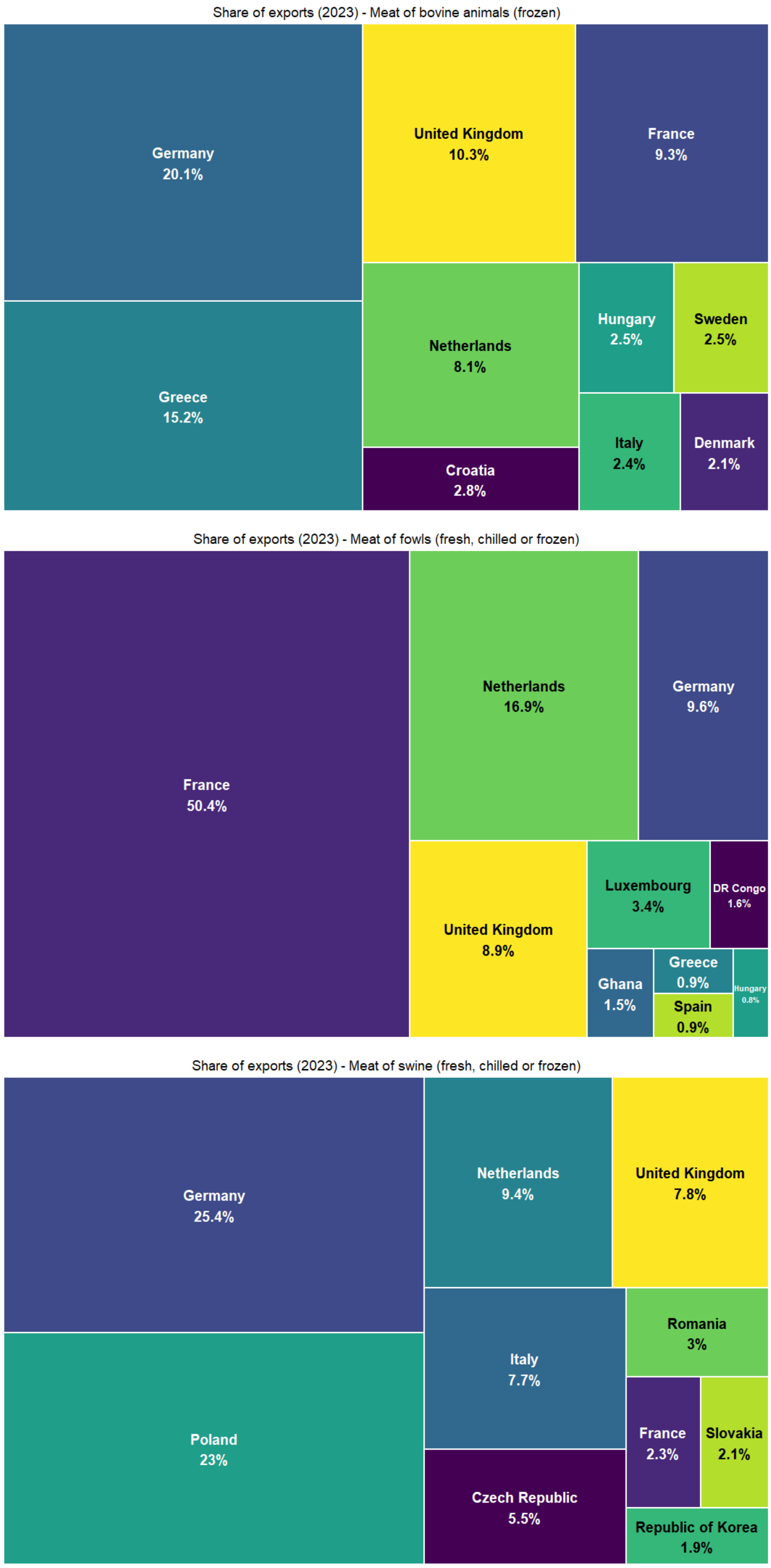

Figure 9: 10 main exporting countries (in share of Belgian exports) for bovine meat (frozen; top, representing 75.3%), poultry (middle, representing 94.9%) and pig meat (bottom, representing 88.1%) in 2023 (ITC, 2025).

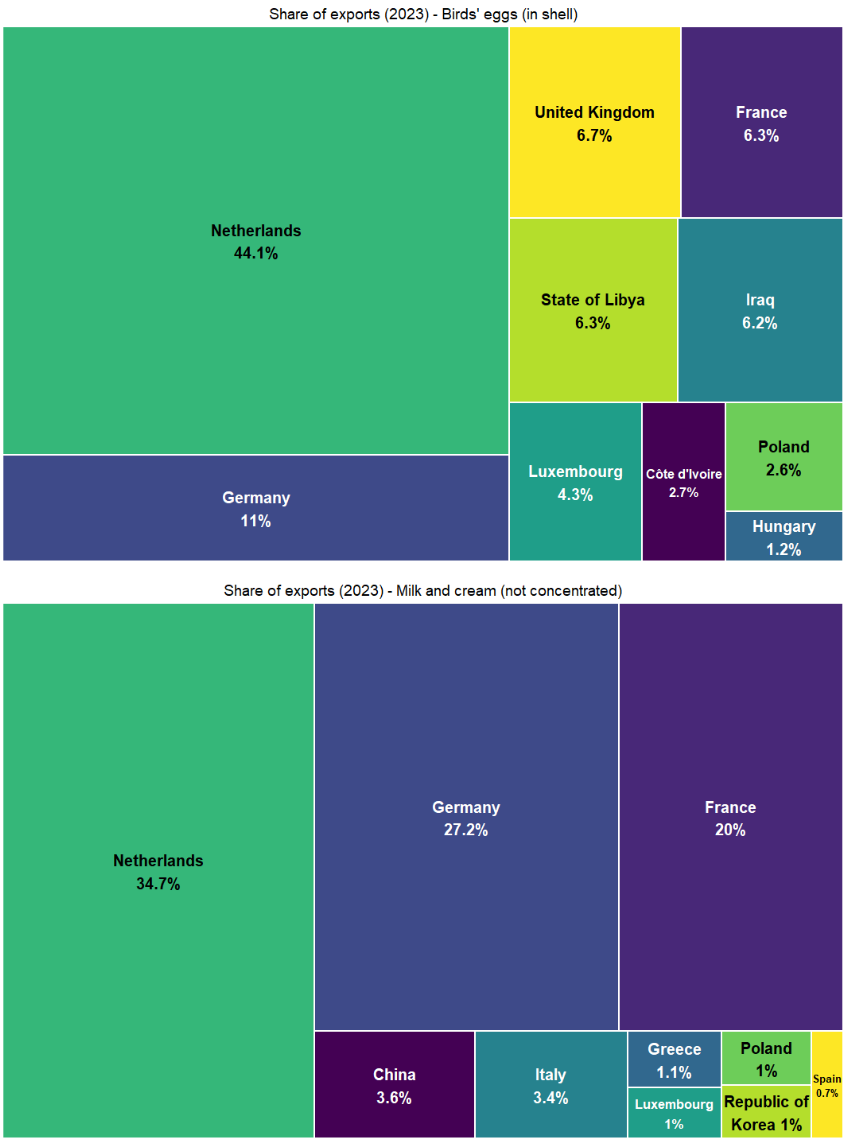

Figure 10: 20 main exporting countries (in share of Belgian exports) for eggs (top, representing 91.4%) and milk (not concentrated; bottom, representing 93.7%) in 2023 (ITC, 2025).

2.2.3.1.1 Reduction in feed and forage production

Due to the reduction in livestock, feed and forage requirements decrease, making land available for other uses. The estimation of the cropland area no longer needed for feed production is based on information on livestock production systems in Belgium and their total feed requirements, as detailed in Riera et al. (2019). Table 8 provides an overview of these calculations. Livestock production decreases by 70% for pigs, by 71% for beef and by 45% for dairy cows, and poultry production declines with 28% (Agora Agriculture, 2024). The current total cereals intake for pigs, poultry, and bovine animals is converted into hectares per year based on average yield of wheat, grain maize and barley. Subsequently, this cereal intake is adjusted to reflect the projected reduction in livestock production by 2050. This allows for a comparison of cereals intake before and after livestock reduction, to assess the potential decrease in cropland demand for feed production. Since the cereals intake figure represents overall demand – without differentiating between domestic production and imported feed – it is assumed that domestic feed crop production would decrease proportionally, i.e. by the same

62%. Assuming a current total of 310 000 ha of cereals, with 61% allocated for animal feed (189 000 ha) (see Part 2 – Agriculture), a 62% reduction would thus theoretically free up approximately 117 000 ha of cropland.

Table 8: Derivation of reduction in cropland for feed based on total cereals intake taken from (Riera, et al., 2019). The total cereals intake reflects overall demand and does not distinguish between domestically produced cereals and those imported for feed purposes. The conversion of cereal intake to ha/year was done based on average yields of wheat (9.1 t/ha), grain maize (11.7 t/ha) and barley (8.6 t/ha), and rounded to the nearest hundred.

	Cereals intake (kt/yr)	Cereals intake (ha/yr)	Scenario (%)	Cereals intake by 2050 (ha/yr)	Current cereal production for feed (ha)	Cereal production for feed by 2050 (ha)
Pork	2671	284 000	-70%	85 200		
Broilers	408	42 400	-28%	30 500		
Laying hens	234	22 100	-28%	15 900		
Dairy cows	75	8200	-45%	4500		
Bovine	206	22 600	-71%	6600		
Total		**379 300**		**142 700**	**189 000**	**72 000**
Reduction				**-62%**		**-117 000**

As with feed production, the theoretical reduction in forage for the bovine and dairy sector is derived based on forage requirement per head taken from (Riera, et al., 2019) and is detailed in Table 9. Here only an assessment is provided of cropland for forage and temporary grassland, as this is considered cropland in LULUCF. Permanent grassland required for grazing is addressed in §2.2.3.4. A reduction of 71% and 45% is assumed for resp. bovine and dairy production. This livestock reduction translates into a proportional reduction of 56% in forage demand. Assuming a current total of 194 000 ha forage crops and 94 000 ha of temporary grassland (see Part 2 – Agriculture), a 56% reduction would theoretically free up approximately 161 000 ha of cropland for forage (Riera, et al., 2019).

Table 9: Derivation of reduction in cropland for forage and temporary grassland based on (Riera, et al., 2019)[3]. The total forage requirement reflects overall demand and does not distinguish between domestically produced forage and imported forage. The number of animals is based on Statbel data for the year 2022 for Flanders and Wallonia (Statbel, 2025).

		Forage (ha/year per animal)	Temporary grassland (ha/year per animal)	Forage & temporary grassland (ha/year)	Scenario (%)	Forage & temporary grassland by 2050 (ha/year)	Current forage and temporary grassland (ha)	Forage and temporary grassland by 2050 (ha)
Bovine[1]	FL	0.13	0.07	55 900	-71%	16 200		
	WAL	0.07	0.07	31 500	-71%	9100		
	BEL			87 400		25 300		
Dairy	FL	0.21	0.05	90 000	-45%	49 500		
	WAL	0.16	0.04	37 800	-45%	20 800		
	BEL			127 800		70 300		
Total	**FL**			**145 900**		**65 700**		
	WAL			**69 300**		**29 900**		
	BEL			**215 200**		**95 600**	**288 000**	**127 000**
Reduction						**-56%**		**-161 000 ha**

[1]Bovine: suckler cows + veal calves

Combining the reduction in area of land for feed crops (-117 000 ha) and for forage (-161 000 ha), a total of **278 000 ha** of cropland would become available due to dietary changes and a corresponding reduction in livestock production.

The majority of forage crops (66.5%) in Belgium is grown in Flanders, as livestock production is also mainly focused in Flanders. Figure 11, based on the 2022 agricultural parcel registration, shows the distribution of cereals (61% assumed to be used as feed), maize, other forage crops, and other cropland. It also illustrates that maize – largely cultivated for feed – is primarily grown in Flanders. Consequently, most of the land that could become available due to a reduction in livestock is situated in Flanders.

[3] For Flanders, the figures for bovine production are based on the predominant intensive maize production system. In Wallonia, an average was taken from all bovine production systems in Wallonia as described in (Riera, Antier, & Baret, Study on Livestock scenarios for Belgium in 2050, 2019). The forage requirements of dairy production are estimated based on reported shares of production systems.

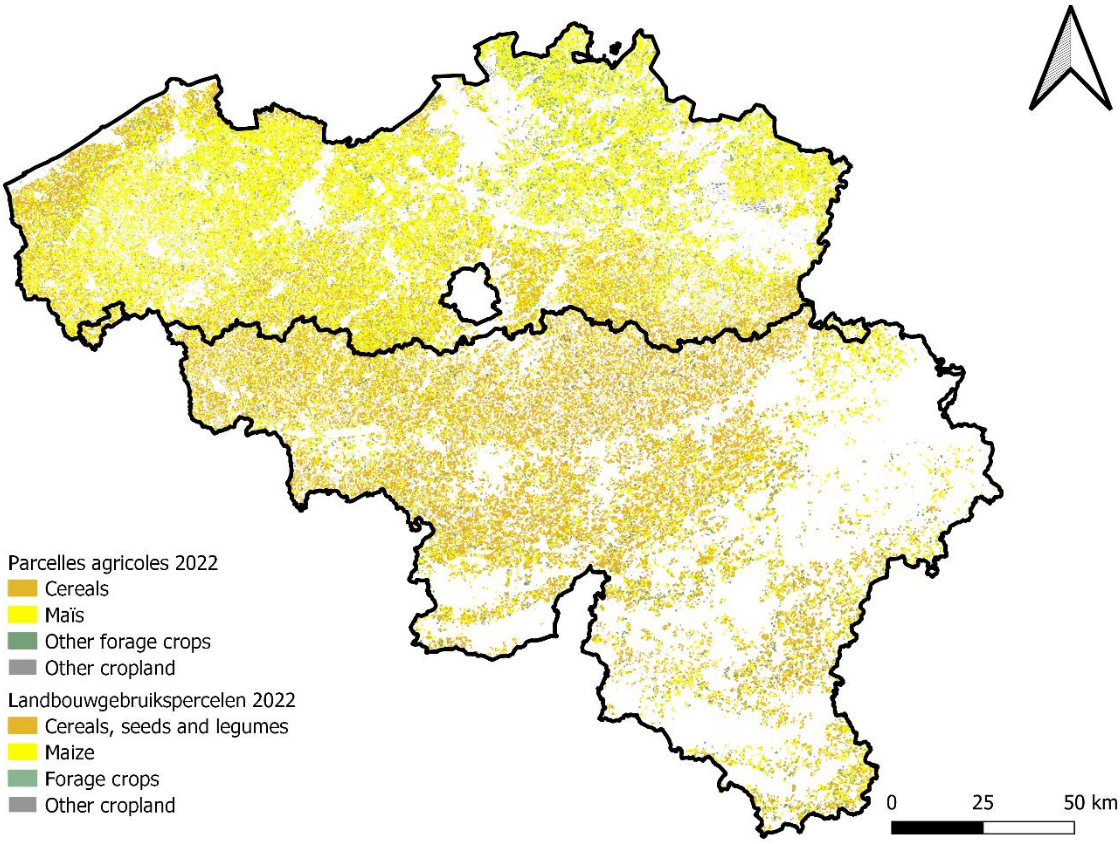

Figure 11: The distribution of maize, cereals, other forage crops and other cropland in Flanders and Wallonia according to the agricultural parcel registration of 2022 (Service public de Wallonie (SPW), 2023)

2.2.3.2 Local production of plant-based proteins for human consumption

As the protein shift from animal-based to plant-based requires an increase in plant-based proteins, increasing local production of these proteins strengthens food sovereignty. The diet proposed by Agora suggests 350 kcal per day of plant-based protein, with half of this coming from plant-based meat substitutes and the other half from pulses (Agora Agriculture, 2024), which translates to a consumption of approximately 74 grams of pulses per day (Danckaert, et al., 2013). In comparison, current consumption in Belgium is only around 4 grams per day from pulses and plant-based meat substitutes (De Ridder, et al., 2016). Using the same assumptions of the calculation of the food footprint in Flanders of (Danckaert, et al., 2013) – i.e., the cultivation of green beans with a yield of 12 ton/ha – around 28 500 ha of cropland for pulses would be required to meet the proposed consumption levels of plant-based proteins.

Currently, Belgium cultivates about 18 400 ha of pulses, an additional **10 000 ha** would thus be required to fulfill the proposed consumption levels.

Belgium is the fifth-largest importer of leguminous vegetables worldwide (ITC, 2025). Increasing the area dedicated to pulses in Belgium would thus strengthen the theoretical self-sufficiency in plant-based proteins, reducing dependency on imports and contributing to a more sustainable agricultural system.

2.2.3.3 Agricultural area allocated to biodiversity – establishing semi-natural woody landscape features

Establishing semi-natural landscape features on cropland enhances biodiversity within agricultural landscapes while also boosting carbon sequestration (Golicz, et al., 2021). The EU Biodiversity Strategy 2030 of the Green Deal aims to restore high-diversity landscape features on at least 10% of agricultural land by 2030, including woody elements such as tree lines, tree groups, and hedges, alongside other small habitat features. In addition, the EU Nature Restoration Law intends to increase the share of agricultural land that includes high-diversity landscape features, reinforcing the ambition to reverse biodiversity loss in farming areas. However, reaching a 10% share of landscape features on agricultural land is not a binding target in the Nature Restoration Law (European Parliament and the Council of the European Union, 2024).

In the major change scenario, the ambition of the EU Biodiversity Strategy is implemented by allocation 10% of agricultural land to biodiversity area, including semi-natural landscape features. Decreasing the parcel size to 5 ha would entail the realization of this 10% semi-natural landscape features, while also increasing crop diversity (Annex 1). Based on European Copernicus Land Monitoring Service earth observation data, which provides comparable data in Flanders and Wallonia, woody landscape features covered 4.15% of agricultural land in Belgium in 2018: 4.8% in Flanders and 3.6% in Wallonia (European Environment Agency, 2024)[4]. The major change scenario therefore involves more than doubling the current extent of these semi-natural features to reach the 10% target.

2.2.3.4 Grasslands: preservation of permanent grassland

Currently, there's around 475 000 ha of permanent agricultural grassland in Belgium, of which the majority (around 65%) is situated in Wallonia (See Part 2 – Agriculture). Intensive, maize-based systems make up the majority of bovine and dairy production systems in Flanders, with extensive grassland-based systems forming a neglectable share, while production systems are more diverse in Wallonia, where extensive grassland systems are also more common (Riera, et al., 2019). Grazing pressure is expressed as Livestock Units (LSU) per hectare, with 1 LSU representing the grazing needs of 1 adult cow. A conversion factor is used to express other animals in LSU (0.007 LSU for broiler, 0.014 for laying hens and 0.5 for pigs). Based on data from 2022, Belgium has a current livestock density of 2.7 Livestock Units (LSU) per ha Utilized Agricultural Area – including both grassland and cropland–, making it the EU country with the third largest livestock density, after the Netherlands and Malta. In comparison, Denmark and Ireland currently have a livestock density of resp. 1 LSU/ha and 1.3 LSU/ha (Eurostat, 2023).

Verma et al. (2015) demonstrated the importance of grassland as a critical carbon sink, due to rapid biomass growth and belowground carbon storage. However, grassland area has been significantly declining in Belgium (Figure 3), which would lead to a further decrease from 20% to 16% in the reference scenario. As such, the major land use change scenario aims to stop the decline in grassland area and preserve permanent grassland, even as livestock numbers are significantly decreased. This would involve an extensification of dairy and bovine production systems, incorporating a greater share of pasture into their management.

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4 Datasets on semi-natural woody landscape features exist in both regions: *Kleine Landschapselementen in Landbouwgebruikspercelen* in Flanders (Informatie Vlaanderen, 2017) and *Éléments structurants du Paysage* in Wallonia (Service public de Wallonie (SPW), 2023). However, due to the differing nature of both datasets (point, line and polygon vector data in Wallonia and raster-derived polygons in Flanders) comparison is difficult. Therefore, the European dataset was selected to determine the current proportion of semi-natural landscape features.

Generally, the extensification of grassland management – including rotational grazing and lower stocking rates – enhances carbon storage (Conant, et al., 2017). However, a local study found that grassland with a moderate stocking rate of 2.2 LSU/ha still functioned as a stable carbon sink, provided that grazing intensity is aligned with grass growth (Gourlez de la Motte, et al., 2016). The extensification of grazing practices also benefits biodiversity in grasslands (Schneider & Hering, 2024). The estimated minimum number of ruminant animals needed to preserve and manage pasture ranges between 0.5 and 1 LSU/ha (Buckwell & Nadeu, 2018). However, this range is lower than what is usually considered for farming systems. The EU regulation on organic farming stipulates a maximum stocking rate of 2 LSU/ha (Riera, et al., 2019) (European Parliament and the Council of the European Union, 2018).

The dietary change assumed in the major change scenario leads to a reduction in the livestock herd from approx. 1 040 000 cattle (543 400 dairy cows and 496 600 bovine animals) to approx. 442 900 cattle (298 900 dairy cows and 144 000 bovine animals) (Table 7). Maintaining the same grassland area for a reduced cattle herd, would result in a more extensive dairy and bovine production system. Preserving permanent grassland would result in a decrease in stocking rate from 2.2 cattle/ha to around 0.93 cattle/ha grassland. Assuming that all cattle in the herd are considered as 1 LSU each, the stocking rate after the reduction in livestock would thus fall within the range of 0.5 – 1 LSU/ha, referring specifically to cattle and no other grazing animals. Taking into account UAA and all livestock – including besides dairy and bovine cattle also pork and poultry production –, livestock density would drop from 2.7 LSU/ha UAA to approx. 1.24 LSU/ ha UAA in 2050, comparable to the stocking density of Ireland or Denmark (Eurostat, 2023).

Preserving permanent grassland while reducing livestock numbers would thus mean that Belgium's overall stocking rate would fall within the range considered sustainable for grassland management. However, achieving this would require a substantial extensification of current practices. Since most permanent pasture is located in Wallonia – where extensive grassland systems are already more prevalent, it would be important to promote a transformation toward more grassland-based dairy and bovine production systems in Flanders.

2.2.3.5 Rewetting drained agricultural peatlands

Rewetting drained peatlands is a key lever to reduce greenhouse gas emissions and restore natural carbon sinks (Agora Agriculture, 2024). Peatlands are also considered biodiversity hotspots, as is reflected in the stipulations of the European Nature Restoration Law, which states that at least 50% of drained peatlands should be restored by 2050, with at least 25% undergoing rewetting, thus restoring their natural hydrology, which is essential for peat formation and carbon storage (European Parliament and the Council of the European Union, 2024) (ETC-CA, 2022). In the scenario proposed by Agora, 80% of drained agricultural peatlands are rewetted and 20% are used as shallow-drained grassland. Of the rewetted peatlands, 80% is used for paludiculture for biomass production (Agora Agriculture, 2024). In the major change scenario, cropland on drained agricultural peatlands will be used as shallow-drained grassland, while grasslands on drained peatlands will be rewetted and restored to wetlands. Although paludiculture is feasible on these lands, the development of supporting value chains is expected to extend beyond 2050 (see Annex 2). The Nature Restoration Law does however consider paludiculture as a possible sustainable land use option to balance productivity with ecological rehabilitation (European Parliament and the Council of the European Union, 2024). To valorize this type of agriculture, further research and knowledge building is thus required (Versyck, et al., 2025). Therefore, compensation for short-term production losses must be considered.

An estimate of peatlands in agricultural use is based on the soil map of Belgium, which is used to identify areas with a peaty texture and/or peaty substrate (Databank Ondergrond Vlaanderen, 2025) (Service public de Wallonie (SPW), 2022). In Flanders, the soil map thus delineates a total of 27 500 ha of peatlands, of which 14 100 ha are in agricultural use. In Wallonia, 16 000 ha of peaty areas are identified, with 1600 ha in agricultural use. Overall, the soil map indicates that 43 500 ha of land in Belgium have peat as texture or substrate (Figure 12). In Flanders, approximately 8500 ha of these agricultural peatlands are covered by grassland, while in Wallonia, this figure is about 1400 ha. This leaves 5600 ha of cropland in Flanders and 200 ha in Wallonia.

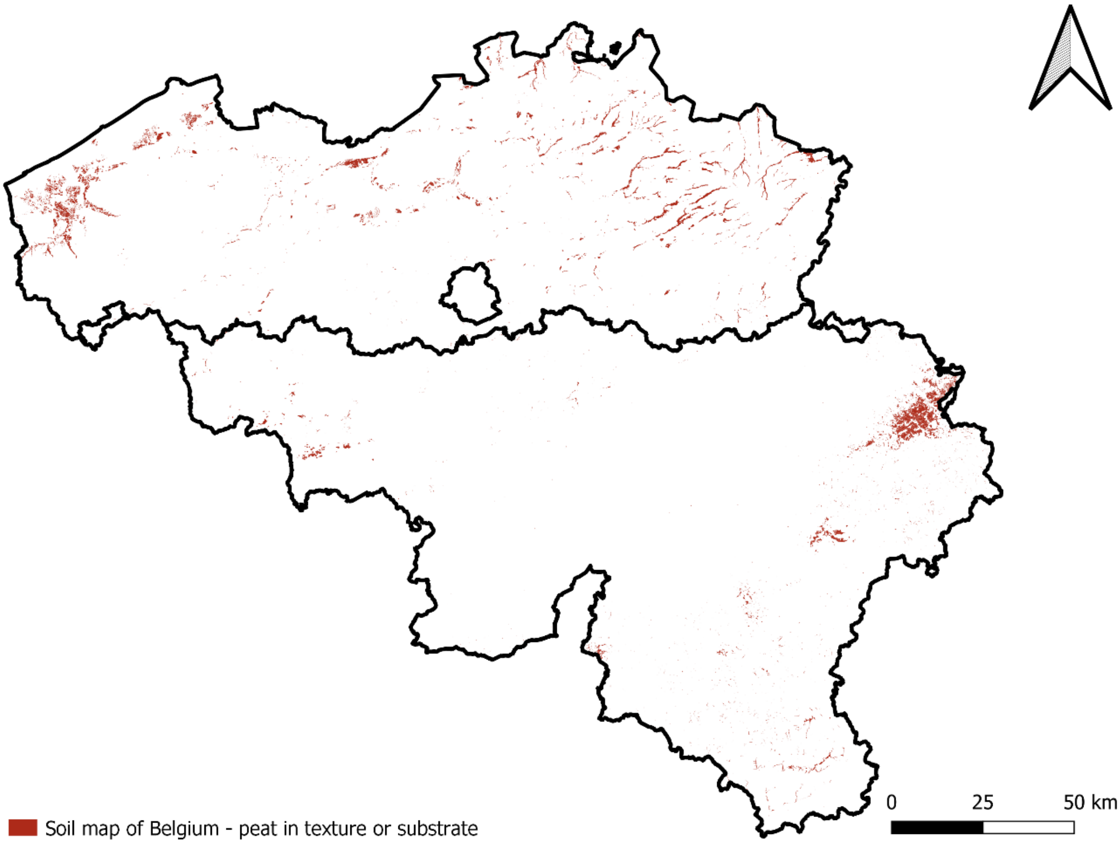


Figure 12: Areas with peat in soil texture or substrate according to the soil map of Belgium (Databank Ondergrond Vlaanderen, 2025) (Service public de Wallonie (SPW), 2022).

The scenario proposes to convert grassland – a total of approx. **9900 ha** – into wetlands, restoring natural vegetation and groundwater tables. Cropland in peaty areas – **5800 ha**, of which approx. 4000 ha feed or forage crops – can be converted into shallow-drained grassland. The cropland not destined for feed or forage crops (2000 ha) and the loss of grassland (10 000 ha) can be compensated in the 278 000 ha of available land.

2.2.3.6 Settlement area

In 2024 around 11.76 million people lived in Belgium, of which 6.82 million in Flanders, 3.69 million in Wallonia and 1.25 million in Brussels. Figure 13 shows the population density in Belgian municipalities, indicating a higher population density in Flanders and Brussels than in Wallonia.

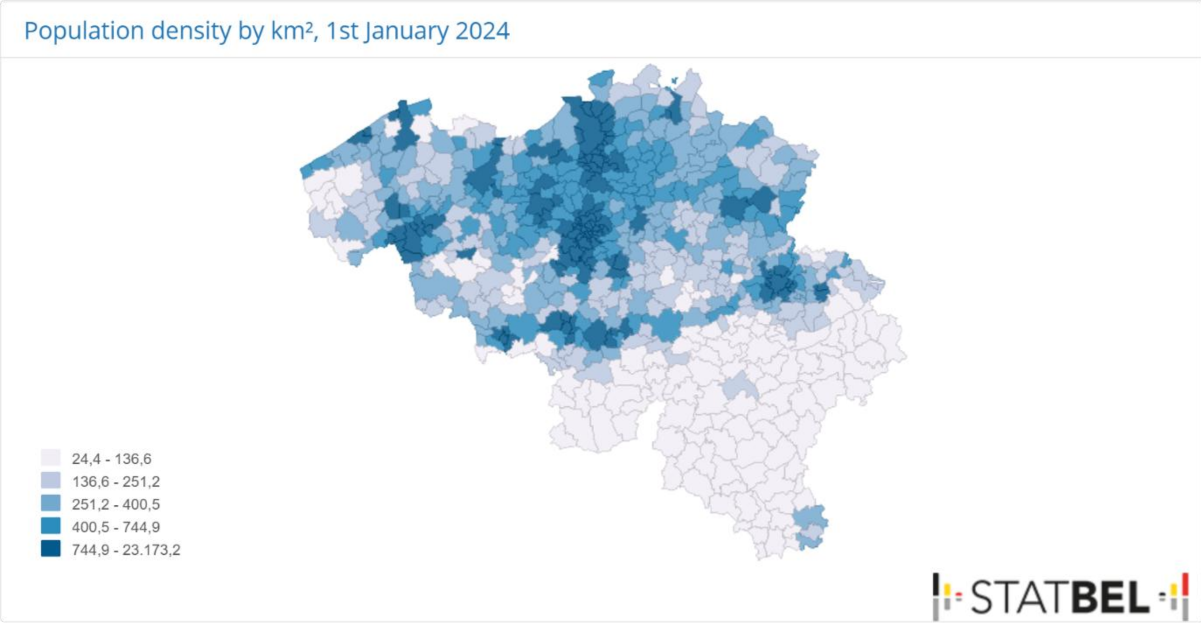


Figure 13: Population density (people/km²) in 2024 (Statbel, 2024).

Demographic projections published by Statbel and the Federal Planning Bureau (FPB) indicate a net population increase of approx. 1.2 million people between 2024 and 2070, with nearly all expected to reside in Flanders (Figure 14). By 2050, the population of Flanders is projected to increase by approx. 765 000 people. In contrast, Wallonia is expected to see a more modest growth of around 89 000 people, while population in Brussels is anticipated to decrease with 17 000 people by 2050. Between 2050 and 2070, population in Flanders is expected to grow with an additional 426 500 people, while population in Wallonia is projected to decrease after 2050 with approx. 42 000 and population in Brussels continues to decrease with an additional 34 500 people. The projected evolution in household types indicates that single-person households are expected to increase (Statbel; FPB, 2025).

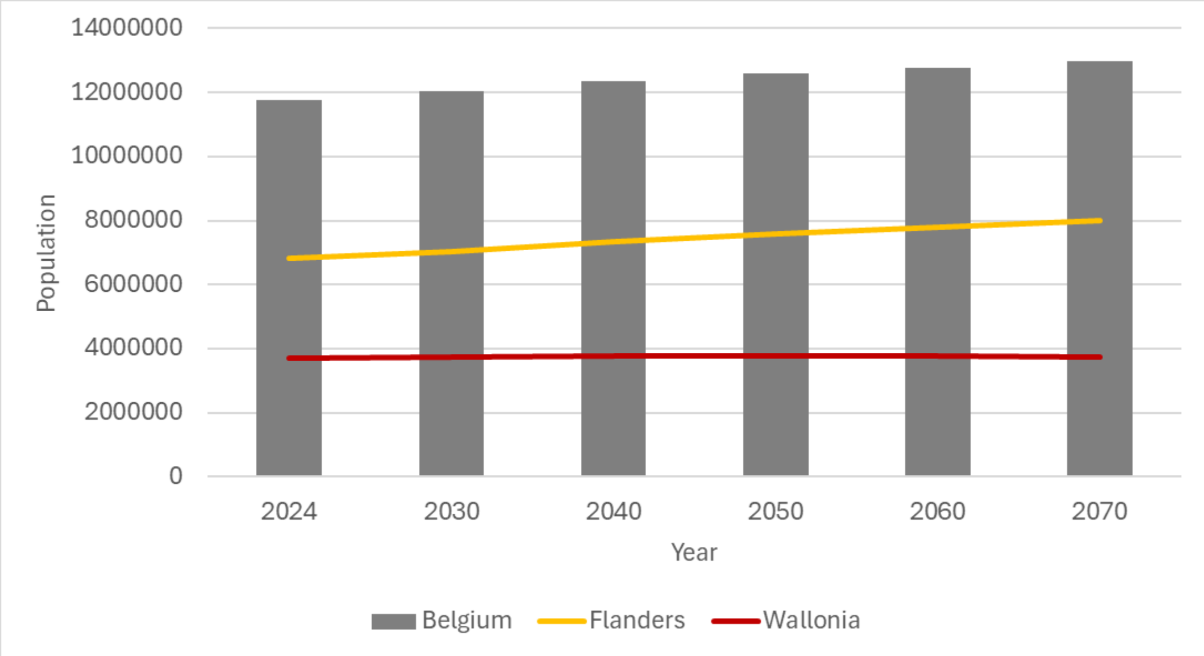


Figure 14: Demographic evolution of the Belgian population, detailed for Flanders and Wallonia, between 2024 and 2070 as projected by Statbel and the Federal Planning Bureau (FPB) (Statbel; FPB, 2025).

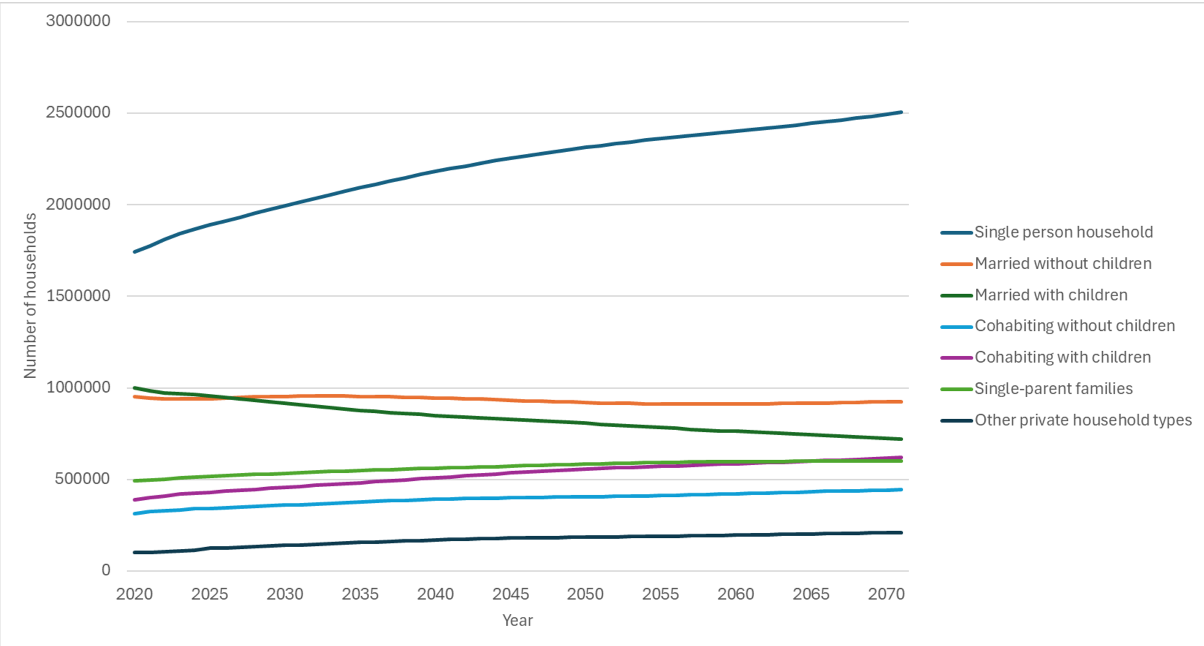


Figure 15: Projected demographic evolution of household types in Belgium between 2020 and 2070 according to Federal Planning Bureau and Statbel (Statbel; FPB, 2025).

2.2.3.6.1 No net land-take by 2030

The EU Soil Strategy for 2030 aims to ensure the protection and restoration of European soils, addressing challenges such as land degradation, pollution and loss of biodiversity. Its objective is to achieve no net land take by 2050, meaning no additional conversion of natural or semi-natural land into artificial surfaces (European Commission, 2021). In Wallonia, the

Stop Béton policy aims to halt urban sprawl and minimize further land artificialization. This policy is embedded in the *Schéma de Développement du Territoire* (SDT). The SDT prioritizes development in central areas, focusing on already artificialized land near services and public transport. It also encourages densification in these areas. The goal is to achieve zero net land take by 2050, in line with EU objectives. To achieve this goal, Wallonia was divided into seven spatial optimization zones. For each of these zones, a linear trajectory to reach 0 ha land-take by 2050 was established based on its level of artificialization (SPW TLPE: SPW Territoire, 2024). Flanders is a highly urbanized region, characterized by urban sprawl. As a result, the *Bouwshift* policy seeks to promote a shift toward more sustainable and efficient land use. The goal is to reduce land take to 3 ha per day by 2025, ultimately reaching zero net land take by 2040 – anticipating the EU's 2050 target. In addition to reducing urbanization, the policy also aims to improve the efficiency of land use on already artificialized areas (Departement Omgeving, 2024).
Achieving zero net land take by 2050 in Wallonia and by 2040 in Flanders would result in a remaining increase in settlement area of approximately 12 000 ha in Wallonia and 16 400 ha in Flanders (Departement Omgeving, 2024). The major change scenario aims to achieve zero net land take by 2030. It is thus assumed that no additional settlement area will encroach (semi-)natural or rural land after 2030 and all urban development will take place in or near already urbanized area, leading to more compact development or vertical densification.

In Wallonia, 12 000 ha of additional settlement area represents a maximum, as there is substantial opportunity to accommodate development within already urbanized areas, as is also outlined in the SDT (SPW TLPE: SPW Territoire, 2024). The number of households in Wallonia is expected to increase with 135 000 by 2050 (Statbel; FPB, 2025). Assuming a linear decrease of artificialization to 0 ha by 2030, and using the level of artificialization of the spatial optimization zones outlined in the SDT trajectories (SPW TLPE: SPW Territoire, 2024), approx. **1500 ha** of additional artificial land will be required by 2030. Given the relatively lower population density (Figure 13) and the regional spatial planning policy focused on targeted densification, it is assumed that the additional 1500 ha of artificial land will be sufficient to meet the increase in housing demand arising from demographic changes by 2050, especially considering the projected population decrease in the region after 2050.

Future housing needs in Flanders by 2035 were assessed by (Verachtert, et al., 2022), estimating a demand for approximately 295 000 additional residential units by 2035 by equating the increase in housing demand to the increase in households. To explore how this demand could be accommodated, several spatial housing scenarios were modelled, each reflecting different assumptions about land use efficiency and development patterns. Under the most compact scenario, which prioritizes well-located and space-efficient residential development, there is sufficient potential to meet this demand with an excess of approx. 360 000 residential units. This scenario would require the development of only **7000 ha** of currently unbuilt residential parcels (Verachtert, et al., 2022). As the number of households in Flanders is expected to increase by approximately 238 000 between 2035 and 2050, the surplus of residential units projected by the compact scenario would be sufficient to meet housing demands through to 2050. However, implementing this spatial policy would require revising the land-use designation of some residential plots, which could lead to planning compensation costs.

2.2.3.6.2 Reallocation of settlement area in areas with high flood risk

Not all existing settlement areas are ideally located: climate change is expected to increase flood risk, resulting in more frequent and damaging flood events in certain regions. Regional policies acknowledge this risk and aim to limit urbanization in flood prone areas (SPW TLPE: SPW Territoire, 2024) (Departement Omgeving, 2024). Currently, 15 400 ha of settlement area in Flanders are located in zones prone to fluvial and/or pluvial flooding, with a 100-year return period (Vlaamse Milieumaatschappij, 2023) (Vlaamse Milieumaatschappij, 2023) (Poelmans, et al., 2023). In Wallonia, approx. 7200 ha of settlement area are located in zones prone to flooding with a 100-year return period (Service public de Wallonie (SPW), 2021) (Service public de Wallonie (SPW), 2019). In total approx. **22 600 ha of settlement area** would thus need to be reallocated to more suitable areas, in line with the principles of regional spatial policies, prioritizing development in or near already urbanized or artificialized land. In the major change scenario, it is assumed (for simplicity) that this additional settlement area is compensated on the cropland formerly used for feed and forage production. While it is uncertain whether densification and spatial optimization alone will fully offset this expansion, the major change scenario takes a precautionary approach by assuming that this settlement area is compensated. For simplicity, it is further assumed that the required area is compensated by converting cropland previously used for feed and forage production.

2.2.3.7 Allocation of land between afforestation and non-food crop production

After allocating land to the additional legumes (10 000 ha), rewetting agricultural peatland (15 700 ha), and the (re)allocation of settlement area (8500 ha and 22 600 ha), **219 400 ha** of land remains available for reallocation. During the workshop (Annex 1), participants were invited to discuss the potential allocation of this land to forest, grassland or cropland for non-food crops and to asses the implications for climate mitigation and adaptation, biodiversity, food security, bioeconomy, cost, and other factors. As the option of additional grassland conversion is addressed in §2.2.3.4, this section focuses on the distribution of the remaining land between forest and cropland for non-food crops. Arguments and considerations for afforestation and the establishment of additional non-food crops, as discussed during the workshop, are provided below, supported by relevant literature.

2.2.3.7.1 Local soy and biomass production

The allocation of cropland to legumes for human consumption is addressed in §2.2.3.2. In this section, the focus lies on cropland for fiber crops to support local bioeconomy and cropland for local soy production to decrease imports of soy. Compared to grassland and forest, cropland has the lowest carbon sequestration potential, although its potential could be enhanced through the implementation of semi-natural landscape features (see §2.2.3.3). Increased cropland availability could drive more sustainable agricultural practices, for instance organic farming and agroforestry. A reduction in parcel size would allow for an increase in integration of semi-natural landscape features, although smaller parcels are less cost-effective.

The import of soy for livestock feed is unsustainable due to its association with deforestation, greenhouse gas emissions, and biodiversity loss (Green, et al., 2019) (Escobar, et al., 2020). The Global Warming Potential (GWP) of imported soybeans is estimated at 3.06 kg CO_2eq/kg, of which 70% constitutes emissions due to land use changes (ERM, Universiteit Gent, 2011). Riera et al. (2019) estimates Belgium's total soybean demand at 995 kt, which means that the GWP of Belgium's total soybean demand thus equals currently approx. 3044.7 Mt CO_2eq., of which approx. 2131 kt CO_2eq can be attributed to land use change. Increasing domestic soybean production by providing incentives for research and development to improve crop quality and yields is a key component of the European Commission's Vision on Agriculture and Food, aiming to develop a strategy to create a more self-sufficient and sustainable EU protein system (European Commission, 2025). In Flanders, ILVO has been researching the potential of local soybean cultivation since 2013 with promising results (Instituut voor Landbouw-, Visserij- & Voedingsonderzoek, 2025). Given the high GWP associated with soy imports and the European Commission's strategy for a more self-sufficient and sustainable protein system, local soybean production is incorporated into the major change scenario. As part of this transition, 'former' cropland currently used for feed and forage will be repurposed for soybean cultivation by 2050.

For Wallonia and Brussels, an estimated 202 kt of soy would be required for current livestock production. Assuming a yield of 3.2 t/ha, this would necessitate approximately 60 000 hectares of land (Riera, et al., 2024). Riera et al. (2019) estimates the total soybean demand for pork, broilers, laying hens, dairy and bovine production at 960 kt. Under the same yield assumption of 3.2 t/ha, meeting the full 960 kt demand would require around 300 000 hectares. However, with livestock reduction, total soybean demand would decrease to approximately 413 kt, reducing the required land area to grow soybean locally to about **129 000 ha** (Table 10), leaving 90 400 ha to be further allocated.

Both Wallonia and Flanders are committed to promoting a circular economy, in which bio-based materials are integrated and value chains – particularly for fiber crops – are further developed. While no concrete targets have been set, a study assessing the potential for 2030 for bioenergy, including energy crops, considered scenarios where 3% to 10% of cropland could be allocated to energy crop production (Colla, et al., 2024). This corresponds to an area of approx. 23 000 ha to 77 000 ha. Currently approx. 25 000 ha of cropland is used for industrial crops, including for instance flax and rapeseed. However, valuing biomass from emerging fiber crops like hemp and miscanthus presents challenges, as existing value chains are predominantly oriented toward animal-based agriculture. Thus, the development of new value chains and the establishment of biomass hubs for the collection, processing, storage, and distribution of biomass materials is required to stimulate the production of non-food crops. It is doubtful whether these value chains will be fully established by 2050. It is therefore challenging to assess the additional need for fiber crops by 2050.

2.2.3.7.2 Forest land

Forest land has the highest potential to sequester carbon in the LULUCF sector compared to cropland and grassland. However, afforesting all available cropland from former feed and forage production, although ecologically possible, is not necessarily desirable as trade-offs need to be considered. Workshop participants highlighted concerns about the visual impact on the landscape, which is also relevant for its recreational value (De Valck, et al., 2017) and could affect public support for widespread afforestation.

The need for afforestation is higher in Flanders, where only 24% of Belgium's forests are located, compared to Wallonia. Forest cover in Flanders is relatively low (approximately 11%), and regional policy aims to expand this by 4000 ha by 2024 and 10 000 ha by 2030. Public support for afforestation is also strong in Flanders, with 9 out of 10 Flemish people expressing a desire for more forests, preferably close to home (Bosalliantie, 2024).

From a biodiversity perspective, forest outcomes depend on management practices. While afforestation can offer benefits, it may also reduce biodiversity by lowering the heterogeneity of the landscape, as more heterogeneous landscapes tend to foster a higher biodiversity (Ryser, et al., 2021). For instance, several pollinator species depend on semi-natural grassland as habitats (Warren, et al., 2021), and forest edges are also associated with high biodiversity (Vanneste, et al., 2024).

Economically, afforestation requires an upfront investment and ongoing maintenance costs, while return on investment is only realized in the long-term. This can pose a barrier for landowners seeking quicker returns. To address this, economic incentives – such as payments for ecosystem services – may be necessary to support and encourage afforestation initiatives.

Forest management plays a crucial role in enhancing carbon sinks and adapting forests to a changing climate. Sustainable forest management practices include lengthening the rotation period, effectively reducing harvest levels, and the establishment of resilient stands – including the diversification of tree species, tree ages and sustainable forest regeneration. This transition is especially relevant in Wallonia, considering its relatively high forest cover of 30%. Regional policy already supports forest owners in adapting their forest management practices through the *Forêt Résiliente* initiative to enhance forest resilience against climate change. The aim is to increase resilient forests in Wallonia from 5% to 25% (Filière Bois Wallonie, 2024). Certain tree species, such as spruce and beech, particularly sensitive to climate variability (e.g., prolonged drought, can be prioritized for harvesting during the transition to more climate-resilient stands. Once resilient stands are established, harvest intensity is expected to decline to levels corresponding with sustainable forest practices. Focusing on harvesting wood products with long carbon storage lifespans can reinforce the Harvested Wood Products sink. In the short term, increasing demand for wood – driven by trends in construction – could thus be met through this transition phase and the removal of the most sensitive species. However, as harvests decrease post-transition, initiatives within the circular bioeconomy can help curb wood demand, aligning with the EU Bioeconomy Strategy (European Commision, 2018). The need to reduce future wood consumption to maintain forest carbon sinks is also demonstrated by a European study (European Commission, et al., 2024), showing that increasing future harvest intensity poses a serious challenge to the forest carbon sink.

The remaining land (94 400 ha) is allocated between forest and crops to support the emerging bioeconomy. Based on workshop insights highlighting the challenges in developing biomass value chains, and considering the goals of maximizing carbon sequestration in natural carbon sinks and enhancing biodiversity in the major change scenario, **80 400 ha** were designated for forest land and **10 000** ha for cropland dedicated to non-food biomass crops.

2.2.3.8 Summary of land use changes in the major land use change scenario

Table 10 summarizes the land use changes as proposed in the major change scenario. These land use changes were translated into land use shares in 2050 and are depicted in Figure 16 and Figure 17.

Table 10: Land use changes as proposed in the major change scenario.

Land available		**278 000 ha**
Forest land		
Cropland to forest land	*Afforestation*	80 400 ha
Cropland		
Cropland remaining cropland	*Local soy production*	129 000 ha
Cropland remaining cropland	*Compensation for loss of non-feed crops on drained peatland*	1800 ha
Cropland remaining cropland (non-food – biobased economy)	*Cropland to support bio-based economy*	10 000 ha
Cropland remaining cropland (food)	*Increasing local production of plant-based protein*	10 000 ha
Grassland		
Cropland to grassland	*Feed crops on drained peatland converted grassland*	4000 ha
Cropland to grassland	*Non-feed crops on drained peatland converted to grassland*	1800 ha
Cropland to grassland	*Compensation for loss of grassland*	9900 ha
Wetland		
Grassland to wetland	*Grassland on peatland converted to wetland*	9900 ha
Settlement area to wetland	*Settlement area in flood prone areas to wetland*	22 600 ha
Settlement area		
Cropland to settlement area	*Additional urbanization before 2030*	8500 ha
Cropland to settlement area	*Compensation for loss of settlement area (reallocation settlements in flood prone areas)*	22 600 ha

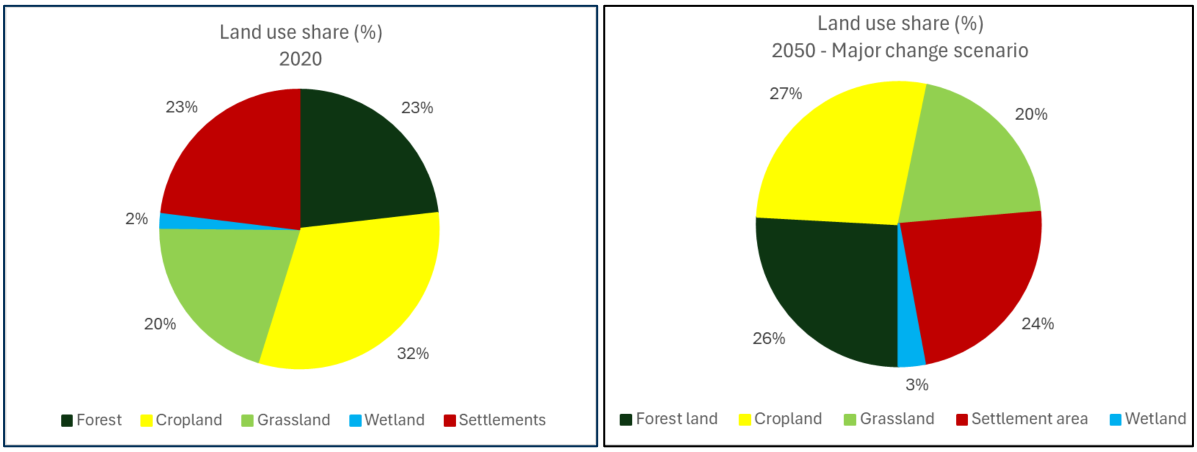


Figure 16: Current land use shares (%) (left) and projected shares (right) of forest land, cropland, grassland, wetland and settlement area in 2050, based on the major land use change scenario.

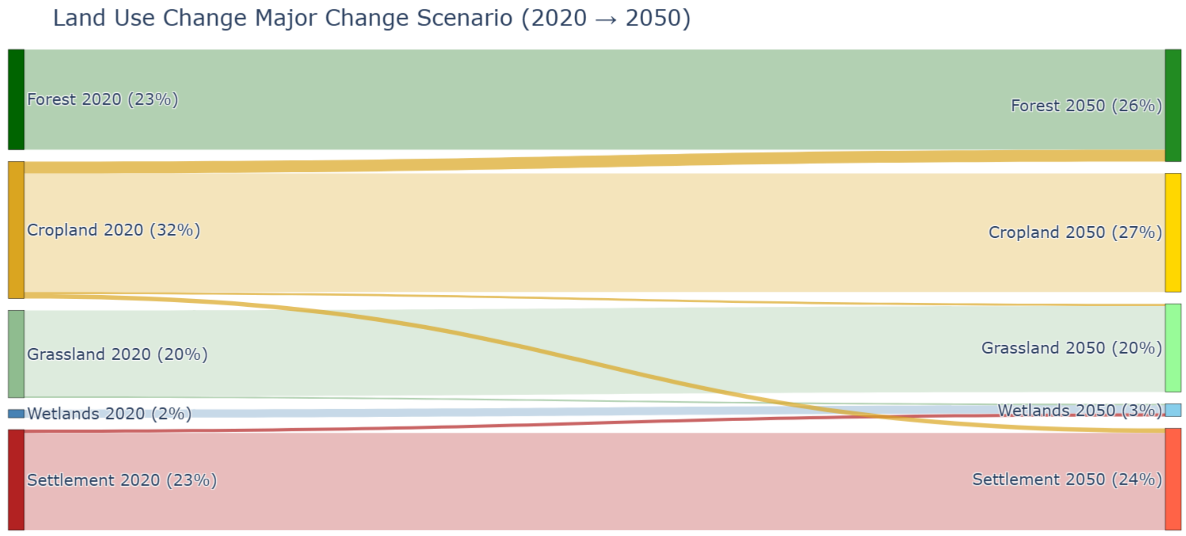


Figure 17: Illustration of the main land use changes according to the major change scenario between 2020 and 2050.

2.2.4 Overview of scenarios

Table 11: Overview of the land uses and land use changes (ha) in the different scenarios (reference, current policy and major change) (rounded to nearest 1000 ha).

	Current (2020) (ha)	Reference 2050 (ha)	*CHANGE (ha)*	Current policy 2050 (ha)	*CHANGE (ha)*	Major Change 2050 (ha)	*CHANGE (ha)*
Forest land	**710 000**	**710 000**	-	**728 000**	***18 000***	**790 000**	***80 000***
Forest land remaining forest land		686 000		694 000		710 000	
Cropland to forest land		3000		5000		80 000	
Grassland to forest land		20 000		29 000		0	
Cropland	**972 000**	**976 000**	***4 000***	**949 000**	***-23 000***	**845 000**	***-127 000***
Cropland remaining cropland		864 000		894 000		845 000	
Forest land to cropland		2 000		2000		0	
Grassland to cropland		109 000		53 000		0	
Grassland	**620 000**	**490 000**	***-130 000***	**593 000**	***-27 000***	**626 000**	***6000***
Grassland remaining grassland		415 000		517 000		610 000	
Forest to grassland		10 000		10 000		0	
Cropland to grassland		64 000		66 000		16 000	
Settlement area	**711 000**	**835 000**	***124 000***	**739 000**	***28 000***	**720 000**	***9000***
Settlement area remaining settlement area		712 000		712 000		690 000	
Forest land to settlement area		10 000		2000		0	
Cropland to settlement area		42 000		9000		31 000	
Grassland to settlement area		70 000		16 000		0	
Wetland	**57 000**	**57 000**	-	**57 000**	-	**90 000**	***33 000***
Wetland remaining wetland						57 000	
Grassland to wetlands						10 000	
Settlement area to wetlands						23 000	
Organic Farming	1.6% Flanders, 13% Wallonia	4% Flanders, 19% Wallonia		16.5% Flanders, 57% Wallonia		40% Flanders, 60% Wallonia	
Biodiversity area (% of total UAA)	4.15% – 4.8% Flanders, 3.6% Wallonia	4.15% – 4.8% Flanders, 3.6% Wallonia		4.15% – 4.8% Flanders, 3.6% Wallonia		10% Flanders, 10% Wallonia	

3 PART 2 – SPECIFIC ANALYSIS ON AGRICULTURE

3.1 Introduction

3.1.1 Context

Agriculture plays a dual role in the global climate crisis: it is both a significant source of greenhouse gas (GHG) emissions and a potential contributor to climate change mitigation. In Belgium, agriculture accounts for 8.8% of total emissions, or 11.1% when including energy-related emission (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Emissions arise mainly from methane (CH4) and nitrous oxide (N2O), while carbon dioxide (CO2) emissions are primary attributable to liming and urea consumption (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Since 1990, the main Belgian agricultural reductions in emissions have been attributed to the reduction in livestock numbers (and associated reductions linked to enteric fermentation), as well as to changes in agricultural practices such as a reduction in the use of synthetic fertilizers (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

To accelerate this transition, a range of international, European, and national policy instruments has been implemented. Global commitments such as the Paris Agreement are implemented by EU-specific policies, such as the EU Climate Law, and the LULUCF Regulation. Carbon farming has recently gained attention as a promising approach to promote resilience and sustainability in agriculture (European Commission, 2024). With agricultural and forest lands covering over 75% of the EU's territory (European Commission 2023), the land sector represents a strategic domain for achieving climate neutrality (European Commission 2024). The Nature Restoration Law and initiatives such as the 4 per 1000 (4‰) campaign underscore the EU's commitment to increasing SOC stocks through targeted land management strategies (Bruni, et al., 2024).

3.1.2 Objectives

The objective of the present part is to analyze the agricultural sector and to define and quantify the potential of natural carbon sequestration of agricultural practices in Belgium.

Table 12 illustrates the three main axes of analysis and their subsequent tasks.

Table 12: Sequence of actions and tasks carried out as part of Part 2 of the project

	Tasks
1. Document the diversity of the existing modes of production	
	Describe the diversity of Belgian agricultural sectors
	Document the diversity of existing modes of production (“systems”)
	Cross-reference information on production methods with carbon farming systems
2. Define the use of production of those different systems	
	Categorize and define the types of use of production
	Match systems and the use of production
3. Document the impacts of systems and the potential switch from one scenario to another	
	Develop impact criteria
	Document the negative and positive emissions of existing systems
	Document the potential emissions of different paths of change

3.1.3 Framework

Before implementing the project’s objectives, it is imperative to elucidate certain definitions and conceptual frameworks that will facilitate their realization.

3.1.3.1 Key definitions and information

3.1.3.1.1 Agricultural land use in Statbel and the NIR

Statbel differentiates different categories of agricultural land according to the CEE-ONU Statistical Classification of Land Use (Statbel, 2025):

- **Arable land**, referred to as “cropland” in this project, includes all land that is regularly sown, whether used for crops, temporary grassland (defined as grass or forage remaining in place for at least one year but no more than five years), or left fallow.
- **Permanent grassland**, referred to as “grassland” in this project, includes land designated for permanent meadows and pastures. It is defined as land continuously used for at least five years to grow herbaceous grass or forage crops and is therefore not typically part of a crop rotation.
- In addition, there is land devoted to **permanent crops**, i.e., land occupied by crops that can wait several years before being replanted, excluding permanent grassland and pasture. Ornamental plants, orchards, and vines are examples.

The definition presented in the National Inventory Report (NIR) differs from Statbel's classification (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024):

- "Croplands include arable and tillage land, and agro-forestry[5] systems where vegetation falls below the thresholds used for the forestland category, consistent with the selection of national definitions."
- "Grasslands include rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold of forest definition and are not expected to exceed, without human intervention, the threshold used in the forest land category."

It is important to note that the classification rules for permanent grasslands in the Belgian NIR align with the guidelines established by the Intergovernmental Panel on Climate Change (IPCC), which defines methodologies for monitoring and reporting GHG emissions.

Specifically, the estimation of soil carbon stock changes in land-use transition areas follows Equation 2.25 of the IPCC 2006 Guidelines, assuming a 20-year transition period for soil organic carbon (SOC) dynamics (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Consequently, under the IPCC framework—and thus within the NIR—a temporary grassland is reclassified as permanent after twenty years of continuous use, in contrast to the five-year threshold applied in Statbel datasets. This affects the areas allocated to different categories of land use (Table 13). While the area of grassland is declining over time, the areas of cropland have remained relatively stable since 1990 (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Table 13 indicates a difference in the total volumes: Statbel is more restrictive and only counts "Used Agricultural Area".

Table 13: Area comparisons (in hectares) between Statbel and NIR data for 2022.

Category	Statbel (ha)	Category	NIR (ha)
Arable land (including temporary grassland, i.e. < 5 years)	863 551	Cropland	971 729
Land devoted to permanent crops (e.g. orchards)	24 005		
Land devoted to permanent grasslands and meadows (i.e. >= 5 years)	471 629	Grassland (i.e. >= 20 years)	619 610
Greenhouse crops	2 726		
Total UAA	1 361 911		1 591 339

3.1.3.1.2 The IPCC sectors and LULUCF

Even though agricultural emissions and carbon sequestration activities may occur on the same land area, their associated emissions and removals are reported separately in the GHG

[5] In Statbel, production systems (practices) are not specified, therefore no specific information on tillage or agroforestry practices are provided. Permanent crops, that require no tillage, are registered as permanent crops (orchards, grape wines, etc.).

inventory, with measures in place to prevent double-counting (European Environment Agency, 2024). While fluxes of CO_2 are predominantly considered in the LULUCF sector, fluxes of CH_4 and N_2O are predominantly considered under the agriculture sector (IPCC, 2022). Besides, emissions from fuel combustion from agricultural machinery or transport on farms and in forestry are included in the energy sector. These emissions are regulated under the Effort Sharing Regulation (ESR) and the EU Emissions Trading System (ETS) (European Environment Agency, 2024).

3.1.3.2 Considerations on carbon sequestration in soils

The project aims to assess the potential of modifying land use and management practices to limit GHG emissions and increase the capacity of Belgian agricultural soils to sequester atmospheric CO_2. To do this, it is essential not to overlook the limits of soil carbon storage.

First, the national Belgian soil carbon stock in the top 30 cm is estimated at 215 Mt, with 108 Mt stored in agricultural soils (Minasny, et al., 2017). A theoretical 4‰ annual increase in SOC would sequester 0.86 Mt C per year, equivalent to just 2.6% of Belgium's total annual GHG emissions (32.6 Mt C/year) (Minasny, et al., 2017). Moreover, this potential is mostly concentrated in the fertile loess belt (located in the central part of Belgium).

Furthermore, the adoption of agricultural practices with a positive carbon impact, such as the conversion of cropland to permanent grassland, has been found to result in a decline in the rate of soil carbon accumulation over time, eventually reaching a plateau (Baveye, et al., 2018).

Finally, while long-term carbon sequestration in agricultural soils is preferred for GHG mitigation, labile fractions are essential for soil fertility, soil physical conditions, and soil biodiversity (Chenu, et al., 2019). Indeed, as Moinet et al. (2023) pointed out in their article, it is necessary to change the paradigm and move toward "carbon for soils" rather than "soils for carbon". Therefore, while increasing the SOC content of Belgian soils is essential to ensure their sustainability (e.g., fertility, resilience to water erosion, etc.), it is recommended that SOC sequestration be considered as a co-benefit for climate change mitigation and an additional strategy for reducing agricultural GHG emissions alongside other tools (Chenu, et al., 2019; Moinet, et al., 2023).

3.1.3.3 Considerations on carbon farming practices and systems

As of today, there is an important lack of scientific data on carbon farming practices and their impacts. It is therefore not possible to establish a clear linkage between identified production systems and specific carbon farming practices in Belgium. In the context of the present study, we have chosen to classify agricultural practices based on accessible and reliable data or statistics. To date, organic farming remains the only production system for which consistent data exists at both regional and national levels. In contrast, other popular "carbon farming systems"—such as conservation or regenerative agriculture—are neither sufficiently defined nor standardized to be included in scenario analyses.

Besides, it is worth noting that organic farming inherently integrates aspects of carbon farming, as it is considered a practice that contributes to enhancing carbon sequestration (Petersson et al. 2025). According to the JRC's Farming Practices Evidence Library (JRC, 2025), when filtered for the sustainability outcome "carbon sequestration," organic farming ranks as the second most frequently studied practice with positive effects (Figure 18).

Accordingly, the study accounts for carbon farming through both land use changes (e.g., cropland converted to grassland) and the share of organic farming. However, to go further in assessing the natural carbon sequestration potential of agricultural practices, we chose to refine the initial scenarios by introducing a set of assumptions to overcome the data limitations (see Methodology section) and explore other agricultural practices. In particular, we explore the potential impact of the increase of biodiversity area (§3.2.5.1.4) and the implementation of agroforestry (§3.2.5.1.5) on both cropland and grassland.

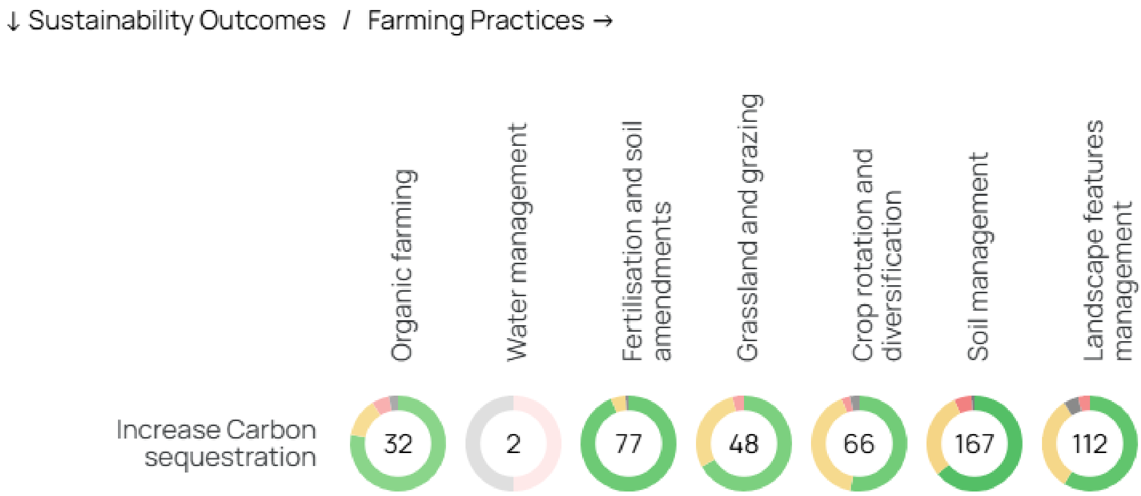


Figure 18: Map of available evidence on the impact of farming practices on increasing carbon sequestration (JRC, 2025).
Legend: The chart illustrates the distribution of results showing significant positive (green) or negative (red) effects, non-significant effects (yellow) or non-statistically-tested (grey) results. Numbers represent the count of available results.

3.2 Methodology

3.2.1 General principles of methodology

3.2.1.1 Scope

A territorial approach has been adopted. This means that the analysis focuses exclusively on agricultural production occurring within Belgian borders. Consequently, imported agricultural products—being produced outside national borders—are excluded from this assessment.

This study is conducted at meso scale rather than micro scale. In other words, we do not examine land use or land use change within specific plots. Instead, we focus on the territorial level, analyzing the number of hectares allocated to each land use category and land use change. Consequently, we do not resort to spatially explicit methods such as maps showing changes in SOC stocks, like those produced by Project 114 of the Walloon Recovery Plan (Centre wallon de Recherches agronomiques, 2024), or the soil monitoring network CMON in Flanders (Oorts, et al., 2024).

The Region of Brussels is not included in the analysis as the agricultural area is minimal (less than 1% of the Belgian UAA in 2022, according to Statbel data).

3.2.1.2 Use and description of a model

Calculations rely on a model of the Belgian agricultural and food system developed within Sytra. The model compiles available information on the current situation of land use area (based on Statbel data), production systems (data consolidated by Sytra) and multiple impact indicators. By setting a series of hypotheses and changing the default input values, the model can be used to design and assess the outcomes of scenarios according to diverse parameters.

The model is based on two elements: (i) input variables and (ii) scenario parameters. These two elements are combined to provide a series of output variables (Figure 19). Each of these elements is explained in detail in the following sections.

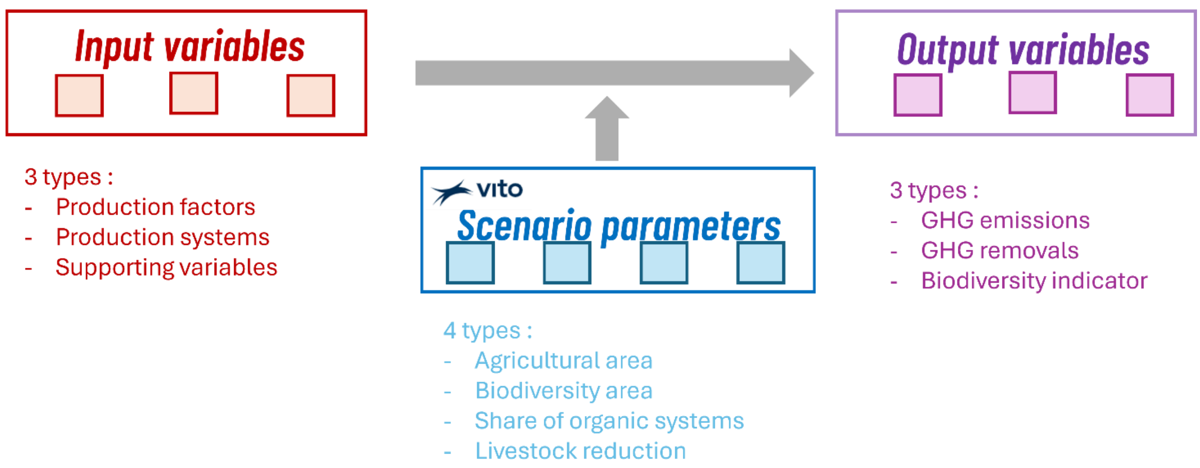


Figure 19: General description of the model: input variables, scenario parameters, and output variables.

3.2.2 Input variables

The model is based on three types of input data: (i) production factors, (ii) production systems (or modes of production), and (iii) supporting variables.

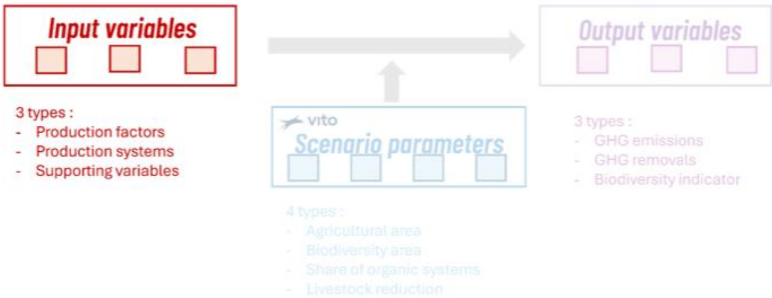


Figure 20: Focus on the input variables of the model

3.2.2.1 Production factors

Production factors are the starting point for calculations. In this study, two main categories of production factors are considered to estimate agricultural productions: agricultural areas, expressed in hectares (ha), and animal populations, expressed in animal numbers (heads). As the study focuses on the impact of land use change and change of practices, more attention will be given to the first production factor than the second.

Production factor data, whether related to agricultural areas or animal populations, originates from the official Belgian statistical office, Statbel. As a reminder, unlike data from the NIR, Statbel's land area data refers exclusively to agricultural land. This explains why the total land areas reported by the NIR are larger than those reported by Statbel (see §3.1.3.1.1). Therefore, the study covers all agricultural production in Belgium documented by Statbel, regardless of whether it has been exported or its intended use (e.g., food, fodder, energy). The box below provides further detail on the temporal and spatial scope of the study.

Reference period and geographical scope

The calculations done in this part of the report consider the years **2018-2022** as the reference period. All results associated with the **current situation** are presented for the average situation during that period.

Regarding the geographical scope, the production factor data is differentiated at the regional level (i.e., Flanders and Wallonia).

Agricultural areas from the Statbel dataset are categorised into ten plant-based sectors, encompassing around forty crop categories (referred to as "products"): cereals (10 products), potatoes (1), sugar beet (1), oil-rich crops (3), protein-rich crops (3), forage crops (4), grassland (2), greenhouse vegetables (2), open-air vegetables (12), fruits (8) (Riera, et al., 2024) (see Annex 3). Alongside these plant-based sectors, five sectors are also included in the assessment: dairy, bovine meat, pork, poultry, and eggs (Table 65 and Table 66 in Annex 3).

Production factors (i.e. the associated hectares and numbers of animals) are presented in Action 1, which aims to describe current agricultural production in Belgium.

3.2.2.2 Production systems

Within each sector, a further categorization is made into production systems. These production systems reflect a set of coherent practices implemented by farmers to produce agricultural outputs.

For plant-based sectors, a distinction is made between non-organic (or “conventional”) and organic systems. For livestock sectors, depending on the sector, the typology includes between two and six production systems, ranging from more extensive practices (e.g. organic or free-range farming) to more intensive ones (e.g. high-productivity indoor animal farming), with intermediate levels of extensification in between (Table 14).

Production systems are considered at the sectoral level (i.e., one typology per sector, rather than per product) and the Belgian level (i.e., the characteristics of a specific production system are considered to be the same in Flanders and Wallonia). However, production system shares are estimated at a regional level and can therefore differ between regions. The proportion of production systems for each sector was defined by expert consultation in previous studies led by Sytra (Riera, et al., 2024).

Table 14: Typologies of production systems considered in the different sectors (Int. = intensive, Ext. = extensive).

Category	***Sector***	***Production systems***					
Plant-based sectors	All	Conventional	Organic				
Animal sectors	Dairy	Diversified Int.	Diversified Ext.	Grass-based Int.	Grass-based Ext.		
	Bovine meat – breeding	Belgian Blue Diversified Int.	Belgian Blue Grass-based Int.	Belgian Blue Diversified Ext.	Belgian Blue Grass-based Ext.	French Diversified Ext.	French Grass-based Ext.
	Bovine meat – fattening	Belgian Blue Int.	Belgian Blue semi-int.	French semi-int.			
	Pork	Conventional	Certified conventional	Differentiated	Differentiated +	Organic	
	Poultry	Conventional	Certified conventional	Differentiated	Differentiated +	Organic	
	Eggs	Cage	Indoor	Free-range	Organic		

As mentioned earlier, beyond accounting for the existing diversity of production systems, this study also aims to investigate the potential for alternative practices, in particular biodiversity areas and agroforestry. However, these are not considered as sector-specific production systems (see box below).

Biodiversity areas and agroforestry

In the context of this study, the implementation of biodiversity areas and agroforestry are explored as two possible avenues to increase the sustainability of the Belgian agricultural system, in particular in terms of carbon sequestration.

In the model, these two categories occupy a somewhat hybrid place between production factors and production systems. Indeed, biodiversity areas and agroforestry are neither associated to specific production sectors or crops (cereals, potatoes, grasslands), nor to specific production systems within those sectors (even though implementing agroforestry entails implementing a specific system with a series of specific practices). Rather, these categories can be found throughout different sectors.

To study the potential of biodiversity areas and agroforestry in this study, the scenario hypotheses allow to set a certain share of agricultural land aside and dedicate it specifically to either of these two categories (Table 16). As explained further, specific hypotheses are made to describe their characteristics and the associated calculations.

3.2.2.3 Supporting variables

Supporting variables make the link between production factors, production systems, and the model outputs. They are generally expressed per production factor (per ha; per head) and are, as far as possible, specific to each production factor and production system.

Supporting variables are very diverse and include elements such as yields, input use (e.g., pesticide or nitrogen fertilizer use), GHG emission factors, and the final uses of the crops. Those variables have been compiled based on various sources[6], and were then shared with sectoral experts for validation and refinement.

3.2.3 Scenario parameters

Building a scenario relies on several variables that impact the model's outcomes. In *Part 1: Land use scenarios*, transition goals, and certain hypotheses are developed. For each of those, the relevant scenario variables (i.e., input variables in the model) were identified, and parameter values were defined (cf. Table 11). Based on this information, it is possible to build and test different scenarios.

Four variables were mobilized in Part 1 to define the scenarios (cf. Table 11 and Table 23). In addition to these four parameters, two complementary variables were added to satisfyingly simulate the scenarios to be tested. The first one (variable 5) reflects the evolution of practices and production systems, through an "extensification" parameter. The second one (variable 6) allows to test aside a share of agricultural land for agroforestry.

1. Agricultural area;
2. Biodiversity area;
3. Minimum share of organic systems;
4. Livestock reduction;
5. Extensification;
6. Agroforestry area.

[6] For example : Statbel, Belgian GHG inventory report, Collège des producteurs, Departement Landbouw en Visserij, Biowallonie, CORDER, etc.

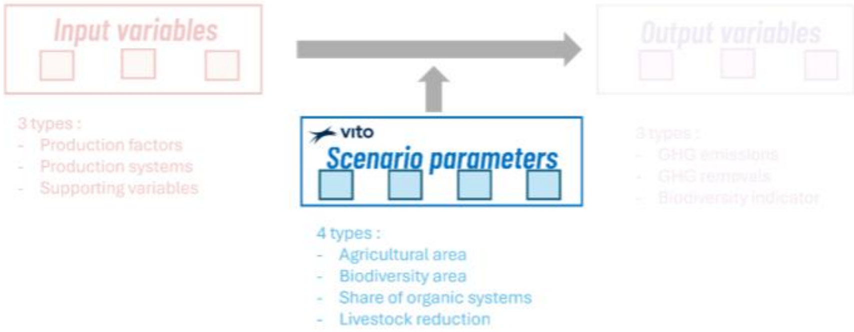


Figure 21: Focus on the scenario parameters of the model

3.2.3.1 Agricultural area

This scenario variable determines the agricultural area considered in each scenario, with specific evolutions per sector and per land use.

As a reminder, the LULUCF sector is a sector used in GHG accounting that encompasses activities related to land use, land use change and forestry. Land use is classified according to the IPCC Good Practice Guidance for LULUCF, which distinguishes between the following six categories: forestland, cropland, grassland, wetlands, settlements and other land (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

As a further reminder, Part 2 of this study specifically focuses on agriculture. Therefore, two of these categories constitute the basis of our analysis: cropland and grassland. This scenario variable sets the evolution of area in both these land uses, and the associated land use changes, thus affecting four land uses and land use changes:

- cropland remaining cropland;
- grassland converted to cropland;
- grassland remaining grassland;
- cropland converted to grassland.

The reference data used is the utilized agricultural area (UAA) provided in Statbel (see box below for more detail).

Comment on data sources in Parts 1 and 2: NIR vs. Statbel

Part 1 of the study was constructed by combining data from both NIR and Statbel (e.g., for the Major Change scenario). In Part 2, to maintain consistency with the agricultural sector, the figures were converted to align with Statbel data, which exclusively considers the utilized agricultural area (Table 16) (1 361 911 ha for Statbel vs. 1 591 339 ha for NIR).

To undertake this task, the areas specified in Part 1 (Table 11) were converted into percentages, with the aim of applying them to Statbel areas. As a result, the absolute areas differ between Parts 1 and 2, but the relative proportions remain consistent.

In addition, the current situation defined in Part 1 is based on data from 2020. As explained above (paragraph 3.2.2.1 on production factors), the period 2018-2022 was selected for the second Part of the project.

3.2.3.2 Biodiversity area

This variable determines the percentage of UAA that is set aside as a non-productive area for biodiversity conservation. This parameter only impacts crop production (including grasslands) and does not affect livestock.

Values set for this scenario variable integrate the existing share of agricultural land considered as biodiversity area, thus making a distinction between ‘existing biodiversity’ and ‘new biodiversity’. In the current situation, around 4% of agricultural land in Belgium is dedicated to biodiversity conservation (Table 11). If the value of this parameter is set at 10%, the initial agricultural area dedicated to each crop is reduced by 6%, which in turns becomes ‘new biodiversity area’.

The model first subtracts the specified proportion of non-productive area before adjusting the remaining agricultural area into croplands and grasslands (scenario variable 1). As a result, in scenarios where the total Belgian UAA decreases, the final proportion of non-productive land will be higher than the value initially entered in the calculator. This implies that, under such scenarios, the total biodiversity area will exceed the specified target. A more detailed explanation of the sequence of calculation of agricultural areas and their distribution in different LULUC categories is provided in the section on output variables, when explaining the calculation of GHG emissions from LULUC (paragraph 3.2.5.1).

3.2.3.3 Minimum share of organic systems

This scenario variable indicates the share of organic production systems compared to non-organic production systems. This calculation is based on the UAA for crops (or “products”).

For each product, the share of organic is set according to the specified parameter value. If the current organic share for a product already equals or exceeds the specified value, the current value remains unchanged. For instance, if the parameter value is set to 30% organic production, and the current production system distribution for a specific product already reaches 35% organic and 65% non-organic, the value remains at 35%. This implies that the total organic share across all products could exceed the specified value, in this example 30%.

3.2.3.4 Livestock reduction

The reduction in livestock numbers will be reflected through five parameters: two relating to the ruminant population (dairy cows and suckler cows) and three relating to the monogastric population (pigs, poultry, and eggs). These scenario variables are expressed as a percentage reduction in the animal population compared to the current situation (affecting livestock populations at one moment in time).

3.2.3.5 Extensification

This scenario variable corresponds to the percentage of switches to extensive systems within non-organic systems. Considering between two to six production systems (depending on the sector), the extensification variables show the effect of an increase in organic systems on the other modes within the non-organic (conventional) system.

For plant-based sectors, only the distinction between organic and non-organic systems is considered (§3.2.2.2). Consequently, extensification is not directly observable in the surface area results, but other indicators such as yields, impacts, etc., account for the extensification of modes within the non-organic category.

Within each sector, all production systems are ranked following an extensification order, with organic farming being generally considered as the most extensive system in a specific sector (among considered production systems). The level of extensification pursued in the scenarios (expressed as a percentage) shifts the targeted percentage of each production system up by one level, i.e. to the next more extensive system.

In this scenario exercise, extensification is fixed at 50% (Table 16), meaning that 50% of the value of each production system is retained and the remainder is added to the next more extensive system (see the example in Table 15). While not following a specific policy or sustainability objective, the choice of this value aligns with a hypothesis of a gradual decrease of more intensive systems (e.g. decrease of intensive cage systems for laying hens).

Table 15: Example of shift between production systems following the extensification variable, with an extensification of 50%. Source: (Riera, et al., 2024).

Extensification rate 50%	System 1 High input conventional	System 2 Medium input conventional	System 3 Low input conventional
Initial area (A)	50	40	30
Area lost (B)	25 (=0.5*50)	20 (=0.5*40)	0
Area gained (C)	0	25 (=0.5*50)	20 (0.5*40)
Final area (D = A - B + C)	25	45	50

3.2.3.6 Agroforestry area

This final scenario variable allows to define the share of agricultural land on which agroforestry is implemented. It is expressed as a share of the utilized agricultural area, after the scenario variables on biodiversity and agricultural area have been implemented. A more detailed explanation of the sequence of calculation of agricultural areas and their distribution in different LULUC categories is provided in the section on output variables, when explaining the calculation of GHG emissions from LULUC (§3.2.5.1).

To account for the fact that agroforestry areas cannot be implemented equally across different types of land and geographical areas, a specific share can be set for cropland and grassland.

In this scenario exercise, the implementation of agroforestry is divided into three levels of ambition across the three scenarios. The Current policy scenario corresponds to the intermediate level and aims to implement agroforestry on 5% of cropland and 15% of grassland (representing 8% of total UAA). This objective aligns with the results from Kay et al. (2019), who concluded that 8.9% of EU agricultural land is under high environmental pressure and would benefit from agroforestry implementation. Departing from this objective and taking an incremental approach in terms of ambition, the Major Change Scenario is assigned an ambitious level, aiming to implement agroforestry on 10% of cropland and 30% of grassland (representing 15% of total UAA). In contrast, the Reference Scenario uses a conservative level, aiming to implement agroforestry on 2.5% of cropland and 7.5% of grassland.

3.2.4 Defining the scenarios

Three land use scenarios have been defined in Part 1 to estimate land use patterns by 2050. The aim of the scenarios is to reflect evolutions in the allocation of land into different land use categories on one side, and the evolution of management practices on the other side. Each scenario is based on a distinct narrative:

- **Scenario 1 - Reference scenario**: This business-as-usual (BAU) land use scenario extrapolates historical and current trends in land use change and management practices.
- **Scenario 2 – Current policy scenario**: This scenario incorporates the implementation of existing and planned Belgian policies influencing carbon sinks through changes in land use and management practices.
  - **Scenario 3 - Major Change scenario**: This transformative scenario significantly departs from historical trends. It is more ambitious than the current policy scenario in its aim to enhance natural carbon sinks, while safeguarding biodiversity and ecosystem functioning.

For each of these scenarios, values for the first four parameters described above were defined in Part 1 (Table 16). Additional values were defined in Part 2 for the two complementary scenario variables: extensification (§3.2.3.5) and agroforestry (§3.2.3.6).

As mentioned earlier (see box in §3.2.3.1), the figures from Part 1 presented in Table 11 were converted to align with Statbel's agricultural area data, which includes only agricultural land, unlike the broader land areas reported in the NIR. Additionally, the totals do not fully reconcile due to rounding in the area values provided in Part 1. Lastly, it should be noted that the emissions generated by land use changes from forest land to cropland or grassland were not included in the scope of Part 2 as it concerned a reduced amount of ha (2000 ha and 10000 ha even further reduced with the conversion to Statbel data). However, the changes of areas were included: the rates of increase and decrease follow the ones indicated in Table 11.

Table 16: Summary of scenario parameters for Part 2. Data from Table 11 were adapted to Statbel data, and the current share of land use comes from the NIR 2021.

Scenario variables (units)	**Scenario 0 - Current situation**	**Scenario 1 - Reference**	**Scenario 2 – Current policy**	**Scenario 3 - Major Change**
1. Agricultural area (ha and %)				
Cropland evolution	859 237	+0.4%	-2%	-13%
Cropland remaining cropland (%)	89%	89%	94%	100%
Grassland to cropland (%)	11%	11%	6%	0%
Grassland evolution	475 096	-21%	-4%	+1%
Grassland remaining grassland (%)	90%	85%	87%	97%
Cropland to grassland (%)	10%	13%	11%	3%
2. Biodiversity area (% of total UAA)				
Flanders Wallonia	4.8% 3.6%	4.8% 3.6%	4.8% 3.6%	10% 10%
3. Minimum share of organic system (% of total UAA)				
Flanders Wallonia	1.6% 13%	4% 19%	16.5% 57%	40% 60%
4. Livestock population reduction (animals and % evolution)				
Dairy (dairy cows)	516 577	-1%	-1%	-45%
Bovine meat (suckler cows)	346 997	-51%	-51%	-71%
Pork (productive pigs)	4 059 544	-8%	-30%	-70%
Poultry (broilers)	35 481 228	+83%	+83%	-28%
Eggs (laying hens)	9 124 326	+42%	+42%	-28%
5. Extensification (% shift)				
Shift to next system	-	50%	50%	50%
6. Agroforestry area (%)				
Cropland Grassland	0% 0%	2.5% 7.5%	5% 15%	10% 30%

3.2.5 Output variables

The model functions as a calculator that generates output variables based on combinations of input variables and scenarios parameters. It is important to emphasize that the model is not an optimization tool: it does not adjust inputs to reach a predefined objective but rather enables a transparent exploration of cause-and-effect relationships within the system.

The model outputs provide results on an annual scale. For instance, in the case of greenhouse gas (GHG) emissions, scenarios are compared based on the amount of CO_2 equivalents emitted per year. This choice reflects the structure of the model, which does not simulate how parameters will evolve over time (e.g. whether changes occur linearly or not). As a result, the model provides a static representation of annual GHG emissions, allowing for comparison between the current situation (2018–2022) and three alternative 2050 scenarios. Emissions are expressed in kilotonnes of CO_2-equivalent per year (kt CO_2eq/yr). Consequently, we assume that the underlying parameters – such as emission factors – remain constant over time.

Three main output variables are considered in the context of this project:

- GHG emissions from land use and land use changes (LULUC emissions)
- GHG emissions from agricultural activities (agriculture emissions)
- Impact of agriculture on biodiversity

The following paragraphs provide a detailed methodological overview of how these output variables are calculated.

Figure 22: Focus on the output variables of the model

3.2.5.1 GHG emissions from LULUC

To estimate the GHG emissions from land use and land use change, the calculations rely on emission factors which are specific to each LULUC category and represent the average emissions per unit of area. To assess the total annual emissions at Belgian level, these emission factors are multiplied by the corresponding area of each LULUC category.

The following paragraphs explain how these calculations are performed. We start by clarifying the LULUC categories which are considered and the sequence that allows to distribute and compartmentalize the total agricultural land in the different LULUC categories. We then move to describing the actual emission factors that are used for the different LULUC categories, differentiating between two reference categories (grassland and cropland) and two additional ones (biodiversity area and agroforestry).

3.2.5.1.1 Considered LULUC categories

As the purpose of this section is to estimate the LULUC emissions from the agriculture sector, we depart from two main land use categories: cropland and grassland. This choice is guided by the fact that these are the main and “usual” categories included in national inventories targeting the agriculture sector. However, restraining the analysis to these two sole categories limits the exploration of alternative forms of land management and practices which could enhance the potential for carbon sequestration in this sector. Thus, to explore the potential of such alternatives, it was decided to extend the scenarios developed in Part 1 through two additional entry points:

- Assessing the carbon sequestration potential of land dedicated to biodiversity;
- Maximizing the carbon sequestration potential of croplands and grasslands by introducing realistic yet high-potential practices—namely, the implementation of agroforestry.

This approach does not assume a radical transformation of agricultural systems but rather builds on practices that are already being applied to some extent in the current context. The goal is to explore their potential if adopted more widely under supportive policy and incentive frameworks.

As a result of the above, for the purpose of calculating the LULUC emissions of the agriculture sector, the agricultural area has been distributed in four main categories of land use: cropland, grassland, biodiversity and agroforestry. Additionally, land use changes from croplands and grasslands to these categories are also considered, resulting in a total of nine LULUC categories (Table 17). The box below provides further detail on the biodiversity category.

New vs. existing biodiversity
In the biodiversity area, as a result of how the biodiversity scenario variable is implemented (see §3.2.3.2), a distinction can be made between 'existing biodiversity' and 'new biodiversity'. The former is directly included and integrated in the productive agricultural area (e.g. through elements such as isolated trees, grass strips, etc). The latter represents additional biodiversity areas implemented in the scenarios. While they can be implemented similarly to the existing biodiversity (i.e. integrated within productive agricultural areas), these areas also provide an opportunity to set aside a certain amount of land from agricultural area as a dedicated land for non-productive biodiversity conservation. This distinction between existing and new biodiversity is also important from a methodological point of view when distributing the total agricultural area into different LULUC categories (as explained in the next paragraph).

Table 17: LULUC categories considered for the calculation of LULUC emissions from the agriculture sector.

LU - level 1	LU - level 2	LULUC
Agricultural area	Cropland	Cropland remaining cropland
		Grassland to cropland
	Grassland	Grassland remaining grassland
		Cropland to grassland
Biodiversity area	Biodiversity	Biodiversity remaining biodiversity
		Cropland to biodiversity
		Grassland to biodiversity
Agroforestry	Agroforestry	Cropland to Agroforestry
		Grassland to agroforestry

3.2.5.1.2 Distribution of areas in LULUC categories

The distribution of the areas in the categories outlined above, follows the hypotheses set on scenario variables (summarized in Table 18 below). As a reminder, the scope considered in Part 2 is the average agricultural area in 2018-2022 as defined by Statbel. The steps and sequence of calculation are detailed below:

- **STEP 1: Calculation of biodiversity area.** A share of the agricultural area is set aside for non-productive biodiversity conservation. A distinction is made between 'existing biodiversity' and 'new biodiversity'. The former is directly included and integrated in the productive agricultural area. In the current situation, this represents respectively 4,8% and 3,6% of the agricultural area in Flanders and Wallonia. It is part of the total agricultural area (i.e. Statbel does not report explicitly on these areas). 'New biodiversity' is additional to these initial percentages. From a methodological perspective, this additional area is subtracted from the total agricultural area.

- **STEP 2: Evolution of productive agricultural area.** The agricultural area is recalculated following the biodiversity hypothesis (i.e. how much land disappears for new biodiversity) and the sector-specific hypotheses (e.g. evolution of cereals, potatoes, grasslands…).
- **STEP 3: Calculation of agroforestry area.** Based on the remaining agricultural area after step 2 (i.e. after considering the biodiversity hypothesis and the evolution of crops), a share of the remaining agricultural area is set aside for agroforestry.
- **STEP 4: Calculation of "usual" LULUC areas (i.e. cropland and grassland).** The areas of cropland remaining cropland, grassland to cropland, grassland remaining grassland and cropland to grassland are calculated based on the remaining agricultural area after step 3, following the scenario hypotheses set.

Table 18: Scenario hypotheses affecting the calculation of areas and their distribution into different LULUC categories.

Step	LU - level 1	LU - level 2	Detail	S0	S1	S2	S3
1	Biodiversity area	Biodiv	Flanders	4.8%	4.8%	4.8%	10.0%
			Wallonia	3.6%	3.6%	3.6%	10.0%
2	Agricultural area	Cropland	Evolution vs. S0	1	1,04	0,98	0,87
		Grassland	Evolution vs. S0	1	0,79	0,96	1,01
3	Agroforestry	Agroforestry	Cropland to Agroforestry	0%	5%	5%	10%
			Grassland to agroforestry	0%	15%	15%	30%
4	Agricultural area	Cropland	Cropland to cropland	89%	89%	94%	100%
			Grassland to cropland	11%	11%	6%	0%
		Grassland	Grassland to grassland	90%	85%	87%	97%
			Cropland to grassland	10%	15%	13%	3%

3.2.5.1.3 LULUC emissions for « usual » categories (cropland, grassland and forests)

To assess the impact of land use changes of agricultural land, emissions are assessed through LULUC-specific emission factors (EF). We first focus on GHG coming from the two main land use categories in the agriculture sector – cropland and grassland – and associated land use changes between both categories. Additionally, we also consider the emission factors of forests (and land use changes from cropland and grassland to forests) as these are later used to assess the emissions of biodiversity area (see next paragraph).

Emission factors for these LULUC categories are calculated based on historical emission data contained in the 2025 submission of the Belgian NIR. We calculate average emission factors for 2018-2022 as this is also the reference period considered for agricultural production factors (agricultural areas and animal numbers). For each LULUC category, the emission factor corresponds to the ratio between the net annual total CO_2 emissions/removals associated with the specific LULUC category and the areas associated with the category during that year (see box below).

Calculation of LULUC emission factors for "usual" LULUC categories based on NIR data.

*Emission factor [kg CO_2/ha/yr] = Net CO_2 emissions/removals [kt CO_2/yr] * 10^6 / (Total area [kha/yr] * 1000)*

The resulting emission factors are compiled in Table 19. It shows **that grasslands are no longer considered as carbon sinks, but rather net sources of carbon emissions (192 kg CO_2eq/ha/yr).** Several factors contribute to this shift. Primarily, it is due to the aging of grasslands: over time, soil carbon stocks tend to stabilize, as carbon inputs from biomass are offset by carbon losses through microbial respiration (Chenu, et al., 2019). In addition, certain management practices—such as intensive grazing, unbalanced fertilization, or reduced carbon inputs—can exacerbate this effect. Under these conditions, carbon outputs may exceed inputs. However, this does not justify converting grasslands to croplands, as such land-use change results in emissions over twenty times higher (5437 kg CO_2eq/ha/yr).

Table 19: LULUC emission factors for main LULUC categories following historical data from the 2025 Belgian NIR submission. Average values for 2018-2022 period.

LULUC category	EF name	Reference	Value (kg CO_2/ha/year)
Cropland remaining cropland	EF_cc	NIR 2025. Avg 18-22	417
Grassland to cropland	EF_gc	NIR 2025. Avg 18-22	5437
Grassland remaining grassland	EF_gg	NIR 2025. Avg 18-22	192
Cropland to grassland	EF_cg	NIR 2025. Avg 18-22	-5453
Forest remaining forest	EF_ff	NIR 2025. Avg 18-22	-1971
Cropland to forest	EF_cf	NIR 2025. Avg 18-22	-21 878
Grassland to forest	EF_gf	NIR 2025. Avg 18-22	-16 432

3.2.5.1.4 Carbon sequestration via biodiversity areas

The biodiversity areas, as defined in Part 1, include hedgerows, linear scrubs, tree rows, and isolated or scattered patches of trees. Due to the lack of detailed information on the precise distribution of these elements within the designated areas, we assume that the characteristics of these biodiversity areas fall somewhere between grassland and forest.

Accordingly, the emission factors for biodiversity areas are calculated based on these two land use categories and associated land use changes from croplands and grasslands. Historical emission data from the 2025 NIR submission is used to calculate average emission factors for 2018-2022. Additionally, for the creation of 'new biodiversity', the scenario timespan is subdivided in two periods:

- a 20-year transition period (2022-2042), where conversion of croplands and grasslands into biodiversity happens. We assume that all of the new biodiversity area engages in this transition from the start (i.e. all the new biodiversity area is implemented at the start of the scenario timespan).
- an 8-year maintenance period (2042-2050), where the newly created and stabilised biodiversity areas are maintained.

The resulting emission factors are compiled in Table 20 and their calculations are detailed in the box below.

Calculation of LULUC emission factors for biodiversity areas based on NIR data.

Emission factor for 'existing biodiversity':

- Biodiversity remaining biodiversity : *EF_bb = EF_ff*0.5 + EF_gg*0.5*

Emission factors for 'new biodiversity':

- Period 1 : 2022-2042 ; 20 years ; 71% period
  - Cropland to biodiversity land : *EF_cb=EF_cg*0.5 + EF_cf*0.5*
  - Grassland to biodiversity land : *EF_gb=EF_gg*0.5 + EF_gf*0.5*
- Period 2 : 2042-2050 ; 8 years ; 29% period
  - Biodiversity remaining biodiversity : *EF_bb = EF_ff*0.5 + EF_gg*0.5*
- Average emission factors over full period :
  - Cropland to biodiversity land : *EF_cb_av = EF_cb*0.79 + EF_bb*0.21*
  - Grassland to biodiversity land : *EF_gb_av = EF_gb*0.79 + EF_bb*0.21*

Table 20 : LULUC emission factors for biodiversity areas, calculated following historical data from the 2025 Belgian NIR submission. Average values for 2018-2022 period.

LULUC	EF name	Reference	Value (kg CO_2/ha/yr)
Biodiv remaining biodiv	EF_bb	NIR 2025. Avg 18-22	-889
Cropland to biodiv	EF_cb	NIR 2025. Avg 18-22	-13 665
Grassland to biodiv	EF_gb	NIR 2025. Avg 18-22	-8120
Cropland to biodiv - aggregate	EF_cb_agg	NIR 2025. Avg 18-22	-10 015
Grassland to biodiv - aggegate	EF_gb_agg	NIR 2025. Avg 18-22	-6054

3.2.5.1.5 Carbon sequestration by the implementation of agroforestry

In addition to the carbon sequestration potential on biodiversity-dedicated lands, we also explore a second lever of action: the implementation of carbon farming practices on croplands and grasslands – more specifically, agroforestry.

Agroforestry was selected as the preferred carbon farming practice due to its high mitigation potential (Aertsens, et al., 2013). It is defined by the IPCC AR6 (in Chapter 7) as "a set of diverse land management systems that integrate trees and shrubs with crops and/or livestock in space and/or time. Agroforestry accumulates carbon in woody vegetation and soil" (IPCC, 2022). Based on the assumption of 100 meters of hedgerow per hectare, the study by Aertsens et al. (2013) estimated the average carbon sequestration potential of agroforestry systems in Europe at 2.75 t C/ha/yr, equivalent to 10.08 t CO_2eq/ha/yr (using the conversion factor of 1 t C = 3.67 t CO_2eq). Therefore, we use a maximum sequestration factor of –10 080 kg CO_2eq/ha/yr in our model. We assume this factor applies equally to agroforestry implemented on croplands and grasslands. Another study compared the carbon sequestration potential of different agroforestry practices in different biogeographical regions in Europe. Considering the results they identify for atlantic and continental regions, an average carbon sequestration of 1.59 t C/ha/yr can be considered, representing -5845 kg CO_2eq/ha/yr. These estimates are specific to carbon contained in biomass but does not account for the potential sequestration of carbon in soils as the authors consider the variability of this sink too high (ranging from -8 t C/ha/yr to +8 t C/ha/yr), and being potentially more influenced by local pedoclimatic conditions and historical land management rather than by the agroforestry practices themselves (Kay, et al., 2019). To complement this, another study focuses specifically on assessing the sequestration potential in temperate soils under agroforestry practices and estimates the sequestration potential at 0.21 t C/ha/yr (Mayer, et al., 2022).

Based on the results from the literature summarized above, we consider three possible emission factors for LULUC emissions under agroforestry, providing us with a possible range of values comprising an optimistic (high), intermediate (mid) and conservative (low) estimate (Table 21).

Given the uncertainty regarding the duration and the dynamics of agroforestry systems, these emission factors are applied over the entire period following the data and approach from Kay et al. (2019) for Atlantic and continental biogeographical regions. Yet, it must be noted that sequestration dynamics are likely to evolve over time, especially since the trees from the implemented agroforestry systems will be harvested at some time, either once after a finite period, which can be long (over 100 years), or at shorter intervals (every 3-5 years).

Table 21: LULUC emission factors for agroforestry areas, calculated following Aertsens et al. (2013); Kay et al. (2019) and Mayer et al. (2022).

EF	Reference & comment	t C/ha/yr	kg CO_2eq/ ha/yr
EF_af_high	Based on Aertsens et al. 2013 (biomass & soils)	2.75	-10 083
EF_af_mid	Based on Kay et al. 2019 (biomass) & Mayer et al. 2022 (soils)	1.59	-5845
EF_af_low	Based on Kay et al. 2019 (biomass)	1.23	-4525

To integrate this factor into our carbon accounting model, we must account for the loss of productive land area resulting from agroforestry implementation. Since agroforestry requires space for tree rows, the initial land area allocated to croplands and grasslands must be adjusted accordingly. The revised land areas must then be used to re-run the model scenarios before assessing the carbon impact of agroforestry.

To estimate the surface area occupied by tree rows, we rely on guidance provided by Agroforestry Vlaanderen. According to their recommendations, each tree row should occupy approximately 4 meters in width (1.8 meters on each side of the tree, plus the trunk and a buffer), and the spacing between rows typically ranges from 28 to 50 meters (Agroforestry Vlaanderen, 2021). For this analysis, we assume a 40-meter spacing between rows. Let us consider a 1-hectare square plot (100 m × 100 m = 10 000 m²). With tree rows spaced every 40 meters and each row measuring 4 meters in width, it is possible to establish three rows, each occupying 4 × 100 = 400 m². This results in a total occupied surface of 1200 m², or 12% of the 1-hectare plot. Consequently, we will reduce the initial cropland and grassland areas by 12% when agroforestry is implemented, to accurately reflect the reduction in productive surfaces before applying the carbon sequestration factor in the model.

3.2.5.2 GHG emissions from agriculture

It is important to note that emissions from the LULUCF sector, as they are derived from NIR data, are relatively coarse: they do not allow for any distinction between crop types or production systems. To account for the impact of agricultural practices, we therefore chose to go beyond the initial scope of the project by including two additional types of GHG emissions: emissions related to crop production and emissions related to livestock.

For crop production, GHG emissions are estimated based on life cycle assessment (LCA) results from the Agribalyse database. These results provide average GHG emissions (in kg

CO_2eq per kg of product or per ha of production) for various types of agricultural production in France, distinguishing between conventional and organic production systems (Riera, et al., 2024). We apply those values (estimation) to Belgium.

For animal production, emissions are estimated based on the results of a study of the Belgian livestock sector (Riera, et al., 2019). This study provides details of the average GHG emissions of various animal productions, with distinctions according to the different production systems (in kg CO_2eq per kg produced).

3.2.5.3 Biodiversity indicator

In addition to indicators on GHG emissions and removals, we also assessed the impact of land use and land-use change on biodiversity. To do so, we relied on the methodology developed by (Chaudhary & Brooks, 2018). Their study quantifies species loss (expressed as a 'damage score') associated with different land-use types—such as croplands and grasslands—by accounting not only for the land-use category but also for the intensity of land management (minimal, light, or intense use). Importantly, their results are spatially explicit at the country level, which includes specific characterization factors for Belgium (Table 22). To apply Chaudhary and Brooks' data to the scenarios, we formulated several assumptions:

- Organic agriculture is considered to reflect low-intensity practices, whereas conventional agriculture corresponds to high-intensity use.
- Temporary grasslands are considered more intensive than permanent ones. Therefore, we assume that organic temporary grasslands have a similar intensity level to conventional permanent grasslands, and both are classified as "light use."
- Land allocated to biodiversity is assumed to have characteristics intermediate between forests and extensively managed grasslands.

Table 22: Calculation details for biodiversity impact indicator.

<table>
<tr><th>Land use types & intensities in this project</th><th>Corresponding land use types & intensities in Chaudhary and Brooks (2018)</th><th>Data source</th></tr>
<tr><td>Cropland – non-organic</td><td>Cropland – Intense use</td><td rowspan="8">Table S5 in Chaudhary and Brooks (2018).
Sum of mean characterisation factors (CF) for Belgium across five taxa (mammals, birds, amphibians, reptiles, plants).
Impacts (CFs) are null for forestland under minimal use (reduced impact logging; RIL) and light use (selective logging)</td></tr>
<tr><td>Cropland – organic</td><td>Cropland – Light use</td></tr>
<tr><td>Temporary grassland – non-organic</td><td>Pasture – Intense use</td></tr>
<tr><td>Temporary grassland – organic</td><td>Pasture – Light use</td></tr>
<tr><td>Permanent grassland – non-organic</td><td>Pasture – Light use</td></tr>
<tr><td>Permanent grassland – organic</td><td>Pasture – Minimal use</td></tr>
<tr><td>Forests</td><td>Managed forests – selective logging or reduced impact logging (RIL)</td></tr>
<tr><td>Land allocated to biodiversity</td><td>Mix of Managed forests and Pasture – Minimal use (50/50)</td></tr>
</table>

3.3 Action 1: Document the diversity of the existing modes of production in Belgium

Action 1 of Part 2 of the project is divided into three tasks. Each of these tasks responds to an objective:

1. Task 1: Describe the diversity of the Belgian agricultural sectors;
2. Task 2: Document the diversity of existing production systems;
3. Task 3: Cross-reference information on production methods with carbon farming systems.

3.3.1 Belgian agricultural sectors

To document the diversity of the Belgian agricultural sectors, we divided them into two objectives:

i) Present the diversity of crops currently grown in Belgium;
ii) Present the diversity of livestock currently bred in Belgium.

3.3.1.1 Current Belgian crops

Table 23 shows the total agricultural area for each plant-based sector in Belgium, Flanders, and Wallonia (see Annex 3 for the agricultural area per product). The first three plant-based sectors in terms of agricultural land used are grasslands, cereals, and forage crops.

Table 23: Distribution of total cultivated agricultural area (expressed in ha) for each plant-based sector, in descending order of the surface area used nationally (Source: Statbel, 2018-2022)

Sector	Belgium		Flanders		Wallonia	
	Ha	% of UAA	Ha	% of UAA	Ha	% of UAA
Grassland	568 839	42.6	221 630	36.2	347 209	48.1
Cereals	310 024	23.2	127 237	20.8	182 787	25.3
Forage crops	193 846	14.5	128 969	21.1	64 877	9.0
Potatoes	93 914	7.0	51 758	8.5	42 157	5.8
Sugar Beet	56 915	4.3	18 630	3.0	38 285	5.3
Open-air vegetables	55 778	4.2	36 336	5.9	19 443	2.7
Other industrial crops	24 699	1.9	4 878	0.8	19 821	2.7
Fruits	19 905	1.5	17 691	2.9	2 214	0.3
Protein-rich crops (legumes)	6 531	0.5	1 059	0.2	5 472	0.8
Greenhouse vegetables	3 882	0.3	3 758	0.6	125	0.0
Total	**1 334 333**	**100**	**611 944**	**100**	**722 389**	**100**

The order of predominance of crops is the same for Wallonia and Belgium. At both levels, the five most important sectors are, in descending order, grassland, cereals, forage crops, potatoes, and sugar beet. In Flanders, the order of the sectors occupying the largest area is different. Open-air vegetables are grown more in Flanders, while sugar beet is grown more in

Wallonia. For Flanders, the order of the main sectors, in terms of area and descending order, is grassland, forage crops, cereals, potatoes, and open-air vegetables.

3.3.1.2 Current Belgian livestock

Table 24 shows the livestock populations in Belgium, Flanders, and Wallonia over the course of a year (with multiple cycles for pigs and poultry), rather than at a single point in time. In terms of head count, the top three categories are broilers, young hens, and productive pigs. To be noted that for certain animal productions, several production cycles occur per year, i.e. the total number of animals raised over one year (indicated here) are greater than the number of animals living at one moment in time.

The ranking of livestock head counts in Flanders mirrors that of Belgium as a whole. In Wallonia, however, the order differs: proportionally, there are more laying hens than young hens. Except for suckler cows, Flanders consistently hosts more livestock than Wallonia.

Table 24: Livestock populations (animal numbers over a full year, accounting for multiple production cycles of pigs and broilers) in Belgium in the current situation (Source: Statbel, 2018-2022).

Sector	***Product***	***Belgium*** *(heads)*	***Flanders*** *(heads)*	***Share Flanders*** *(%)*	***Wallonia*** *(heads)*	***Share Wallonia*** *(%)*
Bovine meat	Suckler cows	346 997	131 338	38	215 660	62
	Young bulls	145 805	97 203	67	48 601	33
Dairy	Dairy cows	516 577	329 605	64	186 971	36
Eggs	Laying hens	9 124 326	7 520 464	82	1 603 862	18
	Reproductive hens	2 429 552	2 260 134	93	169 419	7
	Young hens	11 031 069	10 121 773	92	909 296	8
Pork	Productive pigs	10 923 275	10 066 062	92	857 213	8
	Reproductive pigs	392 343	380 548	97	11 795	3
Poultry	Broilers	243 640 707	204 595 972	84	39 044 735	16
Total		**278 550 651**	**235 503 099**		**43 047 552**	

3.3.2 Production systems

A key feature of this study is its consideration of the diversity of production systems within agricultural sectors. Research shows that, even within the same sector, farms can differ significantly in terms of multiple dimensions, and this diversity is also associated with markedly diverging environmental outcomes among farms. Consequently, a sector’s overall impact depends not only on the number of farms present, but also on the evolving composition of its production systems (Riera, et al., 2024).

To this end, we refer to a previously developed typology of the various production systems within each sector (Table 14). These systems reflect a set of coherent practices implemented by farmers to produce agricultural outputs. Depending on the data availability, the proposed typologies identify and characterize the main archetypal methods of producing each crop or animal product (Riera, et al., 2024).

As a reminder (cf. §3.2), production systems are considered at the sectorial level (i.e. one typology per sector, rather than per product) and the Belgian level (i.e. the characteristics of a specific production system are considered to be the same in Flanders and Wallonia). However, production system shares are estimated at a regional level and can therefore differ between regions. For the plant-based sectors, a distinction is made between non-organic (or conventional) and organic systems (Table 14). For animal production, the typology includes between two and six production systems, ranging from the most intensive level to the most extensive one, with intermediate levels of extensification in between.

Agroforestry and biodiversity areas which are considered as possible alternative land uses are not reported here as they are sector-specific production systems (cf. §3.2.2.2). They are reported when assessing LULUC emissions.

Table 25 and Figure 23 present the distribution of cultivated areas under organic and conventional systems across the various plant-based sectors, as well as their allocation between the two studied regions: Flanders and Wallonia. Wallonia accounts for substantially larger organic areas than Flanders. The contrast is particularly striking in the fruit and greenhouse vegetable sectors, with 30% and 81% of the areas under organic farming in Wallonia, compared to 4% and 1% in Flanders, respectively. Organic production remains marginal in the potato sector (1% in Flanders and 2% in Wallonia). In the sugar beet sector, organic farming appears to be entirely absent in both regions. However, this apparent absence is mainly due to incomplete statistical data regarding organically grown sugar beet. A 2021 survey of industry stakeholders estimated that, in 2019, the area under organic sugar beet cultivation was less than 5 hectares (Courtois & Baret, 2022).

Table 26 presents the distribution of livestock population under production systems across the various animal sectors, as well as their allocation between the two studied regions: Flanders and Wallonia. While extensive and organic production is proportionally more common in Wallonia than in Flanders for bovine meat and poultry, the opposite trend is observed for other types of animal production.

Table 25: Distribution of organic and non-organic agricultural area (ha) for the current situation (2018-2022).

Sector	Production system	Area Belgium (ha)	Area Flanders (ha)	Area Wallonia (ha)
Cereals	non-organic	299 124	125 785	173 340
	organic	10 900	1452	9448
Forage crops	non-organic	191 621	127 679	63 941
	organic	2225	1290	935
Fruits	non-organic	18 525	16971	1554
	organic	1379	719	660
Legumes	non-organic	5680	974	4706
	organic	851	85	766
Other industrial crops	non-organic	23 388	4878	18 510
	organic	1311		1311
Open-air vegetables	non-organic	53 347	35902	17 445
	organic	2431	434	1998
Grassland	non-organic	499 921	219 414	280 507
	organic	68 918	2216	66 702
Potatoes	non-organic	92 553	51 240	41 313
	organic	1361	518	843
Sugar Beet	non-organic	56 915	18 630	38 285
	organic	0	0	0
Greenhouse vegetables	non-organic	3744	3720	24
	organic	138	38	101
All crops	non-organic	1 244 818	605 193	639 625
	organic	89 515	6751	82 764
Total		**1 334 333**	**611 944**	**722 389**

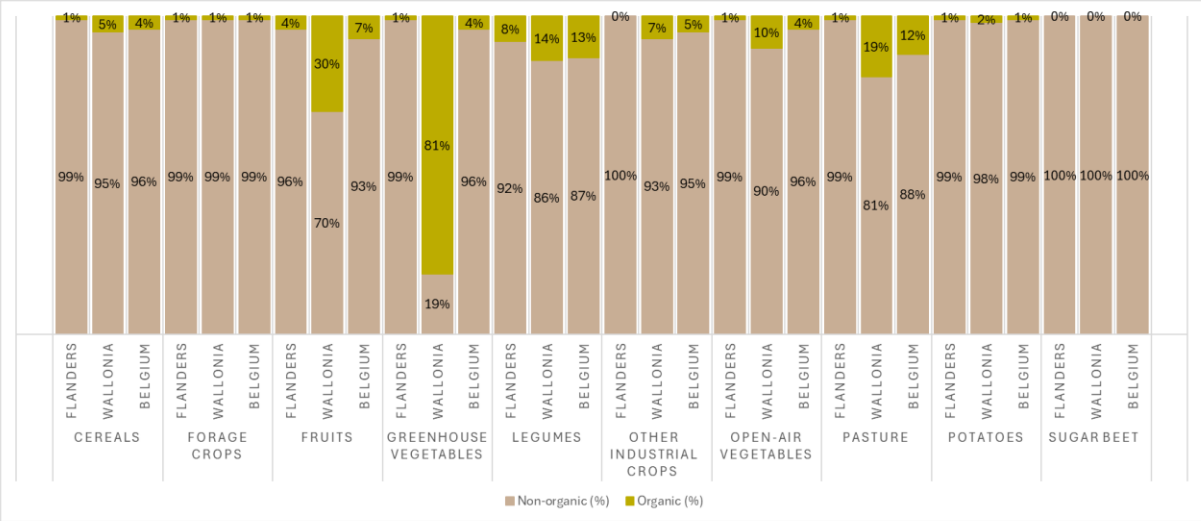


Figure 23: Share of organic (green) and non-organic (brown) areas in Flanders, Wallonia, and Belgium, for the current situation (2018-2022).

Table 26: Distribution of livestock population in production systems (animal numbers over a full year, accounting for multiple production cycles of pigs and broilers) for the current situation (Source: Statbel, 2018-2022).

Product	Production system	Belgium (heads/year)	Flanders (heads/year)	Wallonia (heads/year)
Suckler cows	Belgian Blue Diversified Intensive	163 395	111 637	51 758
	Belgian Blue Grass-based Intensive	38 819	0	38 819
	Belgian Blue Diversified Extensive	45 386	6 567	38 819
	Belgian Blue Grass-based Extensive	43 132	0	43 132
	French Diversified Extensive	34 700	13 134	21 566
	French Grass-based Extensive	21 566	0	21 566
Young bulls	Belgian Blue intensive	102 063	68 042	34 021
	Belgian Blue semi-intensive	29 161	19 441	9 720
	French semi-intensive	14 580	9 720	4 860
Dairy cows	Diversified Intensive	335 428	230 724	104 704
	Grass-based Intensive	28 046	0	28 046
	Diversified Extensive	141 885	98 882	43 003
	Grass-based Extensive	11 218	0	11 218
Laying hens	Cage	4 107 020	3 609 823	497 197
	Indoor	2 732 309	2 331 344	400 965
	Free-range	1 647 367	1 278 479	368 888
	Organic	637 630	300 819	336 811
Reproductive hens	Cage	1 137 384	1 084 864	52 520
	Indoor	742 996	700 641	42 355
	Free-range	423 189	384 223	38 966
	Organic	125 983	90 405	35 578
Young hens	Cage	5 140 333	4 858 451	281 882
	Indoor	3 365 074	3 137 750	227 324
	Free-range	1 929 840	1 720 701	209 138
	Organic	595 823	404 871	190 952
Productive pigs	Conventional	548 038	504 986	43 052
	Certified conventional	9 906 579	9 140 254	766 325
	Differentiated	202 977	187 032	15 945
	Differentiated +	202 977	187 032	15 945
	Organic	62 703	46 758	15 945
Reproductive pigs	Conventional	19 617	19 027	590
	Certified conventional	354 893	344 396	10 497
	Differentiated	7 847	7 611	236
	Differentiated +	7 847	7 611	236
	Organic	2 139	1 903	236
Broilers	Conventional	16 548 702	14 455 952	2 092 750
	Certified conventional	217 253 488	185 862 238	31 391 249

	Differentiated	2 609 189	1 622 607	986 582
	Differentiated +	2 134 791	1 327 587	807 204
	Organic	5 094 537	1 327 587	3 766 950
TOTAL		**278 550 651**	**235 503 099**	**43 047 552**

3.3.3 Cross-Reference with carbon farming systems

The initial aim was to be able to link the production systems defined in the previous section for each plant-based sector to carbon farming systems. However, production systems and carbon farming systems are not defined in the same way. Production systems reflect a coherent set of practices, primarily determined by input use and yield outcomes, that farmers implement to produce a specific crop. Carbon farming systems are practices used by farmers and foresters to enhance carbon sequestration and storage in soils and forests, and to reduce GHG emissions from soils (European Commission, 2025). According to ILVO (Facq, et al., 2025), carbon farming can take the form of either a change in land use, such as converting cropland to grassland, or the introduction of agronomic practices, such as integrating trees or shrubs with crops and livestock in agroforestry.

To effectively track and monitor the impact of carbon farming practices, it is essential to identify those that contribute to carbon storage and sequestration. Next, an inventory of hectares per crop and production system (organic or conventional) is necessary. Finally, the mitigation factor per practice and per hectare must be estimated to calculate the overall mitigation potential.

Despite the potential benefits of carbon farming, several obstacles hinder the monitoring of these practices, their long-term tracking, and, ultimately, the collection of reliable data that could be leveraged in further studies, including our own. The European Commission has identified four key challenges impeding the effective use of carbon farming data:

i. Availability of data: to the best of our knowledge, no meta-analysis has been conducted to compare carbon farming practices with control data.
ii. Reliability of data: Ensuring data reliability remains challenging, as maintaining high-quality datasets is essential for accurate assessments.
iii. The choice and relevance of indicators: outcome indicators are often simplified by area measures, whereas impact indicators often lack clear objectives. This is combined with the large uncertainty in the absolute values of the quantities sequestered, the high influence of the pedoclimatic effect, and the reversibility of practices, associated with a change in impact (e.g. the farmer stops his carbon farming practices and increases his GHG emissions) .
iv. Data maintenance and management pose financial challenges, as the costs associated with monitoring carbon farming data can be prohibitively high.

3.4 Action 2: Define the use of production

Action 2 is divided into two tasks. Each of these tasks responds to an objective:

- Task 1: Define and categorize the types of use of production;
- Task 2: Match agricultural systems and the use of production.

3.4.1 Use of production

Five distinct uses of agricultural land in Belgium are identified, based on the final destination of production:

- Feed – allocated to animal feed;
- Food – intended for human consumption;
- Bioenergy – utilized for bioenergy production;
- Exports – designated for export outside Belgium;
- Other uses – uses not included in the above categories, including, for example, textile production.

3.4.1.1 Limitations and needs

Currently, very little reliable data is available, and the information that does exist is often incomplete or inconsistent with FAO supply balance sheets (Commission Horticulture Comestible, 2018). This scarcity is mainly due to the sensitive nature of agricultural data, with producer federations often refraining from publishing official statistics. To address this gap, we cross-referenced multiple data sources and consulted key stakeholders. Ideally, it would be possible to provide detailed information on the proportion of uses for each crop within each plant-based sector. However, current datasets do not yet allow for this level of granularity. Moreover, existing data do not permit a clear distinction between regions.

This section gives interesting insights on the Belgian food system's orientation and specialization. However, despite efforts from the sector and from research team, no proper data exist to effectively link the final use of production with production schemes and specific information on potential carbon storage potential. Further methodology and results are to be found in Annex 4.

3.5 Action 3: Document the impact of the production systems – Scenario Results

Action 3 of Part 2 is divided into three tasks. Each of these tasks responds to an objective:

1. Task 1: Develop impact criteria;
2. Task 2: Document the net emissions of the existing systems;
3. Task 3: Document the potential emissions of different change paths.

Regarding the development of impact criteria, this corresponds to what we refer to as the model's outputs. Therefore, the first objective, "develop impact criteria", has been addressed and documented in §3.2.5 ("Output Variables") of §3.2 ("Methodology"). The results are presented in three categories of outputs: GHG emissions, GHG removals, and a biodiversity indicator.

For ease of reading, rather than creating two separate sections — one for "Documenting the negative and positive emissions of existing systems" and another for "Documenting the potential emissions of different transition pathways" — we opted to present and compare the different scenarios side by side for each output variable.

In addition to the requested results, we present the impact of the scenario exercises on production factors, such as changes in agricultural areas, livestock populations, production systems and uses, as well as on agricultural production (in kilotonnes per year).

3.5.1 Production factors

The following paragraphs show the evolution of production factors (i.e., areas, animal numbers, and production systems) as a result of the scenario hypotheses that have been set regarding the evolution of these variables (see Table 16).

3.5.1.1 Evolution of agricultural areas

3.5.1.1.1 Indicator description

This indicator reflects the total areas cultivated over one year (i.e., more than one cycle in the case of vegetables).

3.5.1.1.2 Scenario results – total areas

Compared to the current situation (2018-2022), the three scenarios show a clear reduction in the total utilized agricultural area (UAA), from 1.33 million hectares today to 1.16 million hectares in Scenario 3 ("Major Change") (Table 27). This reduction, most pronounced in Scenario 3, is driven by both an increase in land allocated to biodiversity and a significant decrease in cropland area.

Table 27: Distribution of total cultivated agricultural area (ha) for the current situation (2018-2022) and three scenarios in 2050.

Sector	2018 – 2022 Scenario 0 Current situation ha	2050 Scenario 1 Reference ha	2050 Scenario 2 Current policy ha	2050 Scenario 3 Major Change ha
Cereals	310 024	322 425	303 824	253 117
Forage crops	193 846	201 599	189 969	158 770
Fruits	19 905	20 546	19 584	16 824
Greenhouse vegetables	3 882	3 882	3 882	3 669
Legumes	6 531	6 531	6 531	6 110
Other industrial crops	24 699	25 687	24 205	20 111
Open-air vegetables	55 778	56 516	55 409	50 257
Potatoes	93 914	97 671	92 036	76 811
Sugar Beet	56 915	59 192	55 777	46 419
Grassland	568 839	472 819	547 961	526 672
Total	**1 334 333**	**1 266 868**	**1 299 177**	**1 158 759**
Delta vs. current	**-**	**-5%**	**-3%**	**-13%**
Biodiversity areas (ha)	**55 379**	**55 379**	**55 379**	**133 433**
Share of biodiversity areas (%)	4%	4%	4%	12%

3.5.1.2 Evolution of livestock populations

3.5.1.2.1 Indicator description

This indicator reflects the animal populations at a specific point in time, rather than over a full year (which may differ due to the several production cycles for certain animals such as productive pigs and broilers). The latter is reflected in Table 24 and Table 32.

3.5.1.2.2 Scenario results

According to the scenario assumptions, the number of monogastric animals (pigs and poultry) increases by 59% in the Reference scenario and by 51% in the current policy scenario, compared to the current situation (Table 28). In contrast, the Major Change scenario leads to a 32% reduction. For ruminants (dairy cows, suckler cows, and young bulls), all three scenarios project a decline: -25% in both the Reference and current policy scenarios, and -58% in the Major Change scenario.

Overall, the total livestock population increases by 63% and 61% in the Reference and current policy scenarios, respectively, while it decreases by 32% under the Major Change scenario.

Table 28: Evolution of livestock populations (animal numbers at one moment in time) in Belgium at one moment in time in the current situation (2018-2022) and in three scenarios in 2050.

Sector	**Animal category**	**2018 – 2022 Scenario 0 Current situation** heads/cycle	**2050 Scenario 1 Reference** heads/cycle	**2050 Scenario 2 Policy** heads/cycle	**2050 Scenario 3 Major Change** heads/cycle
Bovine meat	Suckler cows	346 997	170 029	170 029	100 629
	Young bulls	145 805	71 444	71 444	42 283
Dairy	Dairy cows	516 577	511 411	511 411	284 117
Eggs	Laying hens	9 124 326	12 956 542	12 956 542	6 569 514
	Reproductive hens	2 429 552	3 449 964	3 449 964	1 749 278
	Young hens	4 242 719	6 024 661	6 024 661	3 054 758
Pork	Productive pigs	4 059 544	3 734 780	2 841 681	1 217 863
	Reproductive pigs	392 343	360 956	274 640	117 703
Poultry	Broilers	35 481 228	64 930 648	64 930 648	25 546 484
TOTAL		**56 739 090**	**92 210 435**	**91 231 020**	**38 682 630**
Delta vs. current			*+63%*	*+61%*	*-32%*

3.5.1.3 Evolution of production systems

3.5.1.3.1 Indicator description

This indicator reflects the distribution of agricultural land and livestock across various production systems. In the plant-based sector, only a distinction is made between organic and non-organic systems. Additionally, the scenarios consider the partial extensification of non-organic systems. Within the animal sector, several production systems are considered within non-organic systems.

3.5.1.3.2 Scenario results – crops

Results in Table 29 and Figure 24 show marked shifts towards organic systems in the three scenarios.

In terms of production systems, the difference in the magnitude of the shift towards organic production between crops depends on the regional distribution of the crops, as the shift is less ambitious in Flanders than in Wallonia.

Table 29: Distribution of organic and non-organic utilized agricultural area (ha) for the current situation (2018-2022) and the three scenarios.

Sector	Production system	2018 – 2022 Scenario 0 Current situation ha	2050 Scenario 1 Reference ha	2050 Scenario 2 Policy ha	2050 Scenario 3 Major Change ha
Cereals	non-organic	299 124	279 205	181 000	122 107
	organic	10 900	43 221	122 824	131 010
Forage crops	non-organic	191 621	183 415	132 874	84 723
	organic	2 225	18 185	57 094	74 047
Fruits	non-organic	18 525	18 887	15 376	9 690
	organic	1 379	1 659	4 208	7 134
Greenhouse vegetables	non-organic	3 744	3 631	3 161	2 154
	organic	138	251	721	1 515
Legumes	non-organic	5 680	5 406	3 237	2 644
	organic	851	1 124	3 294	3 466
Other industrial crops	non-organic	23 388	21 567	12 344	8 847
	organic	1 311	4 120	11 861	11 264
Open-air vegetables	non-organic	53 347	51 082	38 427	26 789
	organic	2 431	5 434	16 982	23 468
Pasture	non-organic	499 921	410 628	322 256	251 480
	organic	68 918	62 191	225 705	275 192
Potatoes	non-organic	92 553	87 187	60 118	39 238
	organic	1 361	10 483	31 918	37 573
Sugar Beet	non-organic	56 915	50 852	31 378	21 632
	organic	-	8 340	24 398	24 787
Total		**1 334 333**	**1 266 868**	**1 299 177**	**1 158 759**

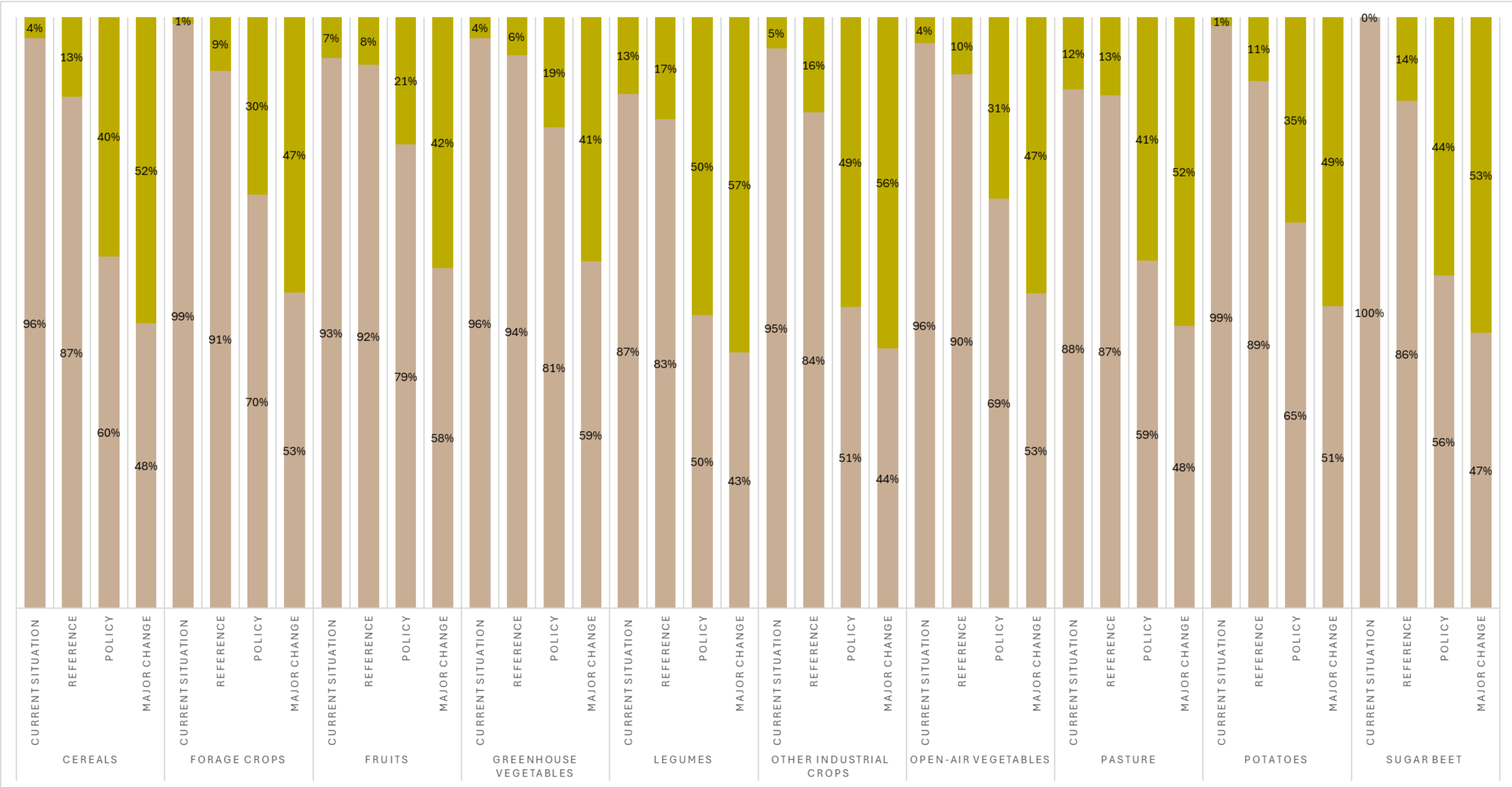


Figure 24: Evolution of the share of organic areas (green) in the current situation (2018-2022) and in the three scenarios in 2050.

3.5.1.3.3 *Scenario results – livestock*

As for livestock, we see an increase of the shares of organic systems in all scenarios, reaching around 5% of livestock populations in the Reference scenario and around 36% of livestock populations in the Major Change scenario (Figure 25 and Table 30).

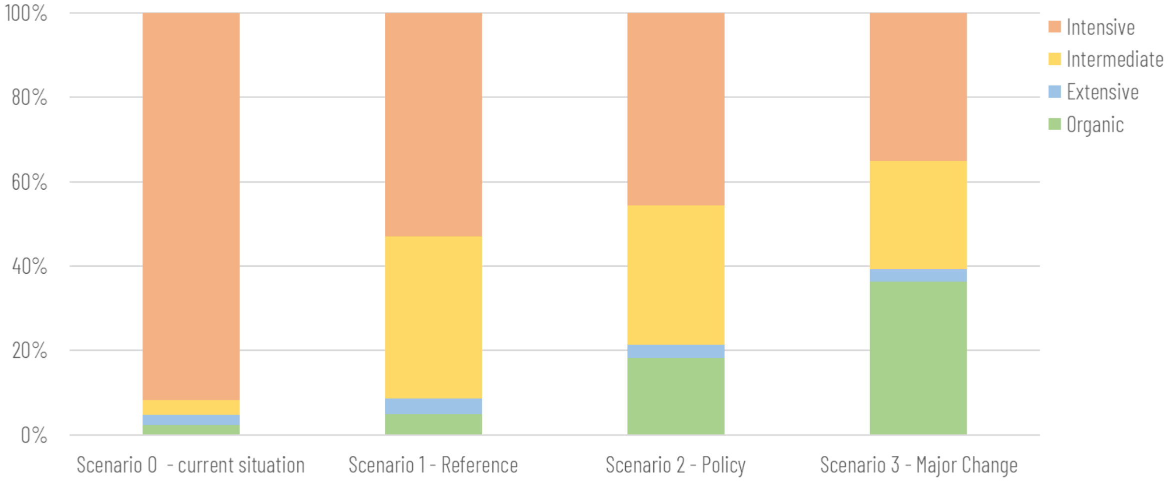


Figure 25: Relative distribution of production systems (%) for the current situation (2018-2022) and the three scenarios (2050).

Table 30: Distribution of livestock population at one moment in time in production systems (number of animals at one moment in time) for the current situation (2018-2022) and the three scenarios (2050).

Product	**Production system**	**2018 – 2022** **Scenario 0** **Current situation** heads/cycle	**2050** **Scenario 1** **Reference** heads/cycle	**2050** **Scenario 2** **Policy** heads/cycle	**2050** **Scenario 3** **Major Change** heads/cycle
Suckler cows	Belgian Blue Diversified Intensive	163 395	37 670	28 897	13 048
	Belgian Blue Grass-based Intensive	38 819	46 229	33 441	15 550
	Belgian Blue Diversified Extensive	45 386	18 664	10 431	5 575
	Belgian Blue Grass-based Extensive	43 132	19 615	10 936	5 853
	French Diversified Extensive	34 700	25 199	15 471	7 844
	French Grass-based Extensive	21 566	22 652	70 852	52 760
Young bulls	Belgian Blue intensive	102 063	24 172	19 449	8 770
	Belgian Blue semi-intensive	29 161	37 985	30 562	13 781
	French semi-intensive	14 580	9 288	21 433	19 732
Dairy cows	Diversified Intensive	335 428	154 301	119 073	50 322
	Grass-based Intensive	28 046	166 263	125 423	53 604
	Diversified Extensive	141 885	142 625	107 566	45 977
	Grass-based Extensive	11 218	48 222	159 349	134 214
Laying hens	Cage	4 107 020	2 915 984	2 421 398	902 838
	Indoor	2 732 309	4 855 924	4 016 080	1 500 478
	Free-range	1 647 367	4 279 201	3 458 854	1 307 436
	Organic	637 630	905 434	3 060 210	2 858 762
Reproductive hens	Cage	1 137 384	807 543	690 257	253 668
	Indoor	742 996	1 335 070	1 139 307	419 032
	Free-range	423 189	1 128 456	953 723	352 470
	Organic	125 983	178 896	666 677	724 107
Young hens	Cage	1 977 051	1 403 706	1 195 877	440 205

	Indoor	1 294 259	2 322 630	1 974 945	727 678
	Free-range	742 246	1 972 913	1 658 640	614 611
	Organic	229 163	325 411	1 195 198	1272 264
Productive pigs	Conventionnal	202 977	89 071	57 383	17 894
	Certified conventional	3 669 103	1 699 433	1 095 290	341 477
	Differentiated	81 191	1 645 991	1 060 860	330 741
	Differentiated +	81 191	106 885	68 860	21 472
	Organic	25 081	193 400	559 286	506 279
Reproductive pigs	Conventionnal	19 617	8 669	5 679	1 757
	Certified conventional	354 893	165 510	108 447	33 551
	Differentiated	7 847	160 308	105 039	32 497
	Differentiated +	7 847	10 403	6 815	2 109
	Organic	2 139	16 066	48 659	47 789
Broilers	Conventionnal	2 364 100	2 089 987	1 730 529	500 634
	Certified conventional	31 036 213	29 513 351	24 273 282	7 044 630
	Differentiated	474 398	27 839 715	22 852 498	6 638 399
	Differentiated +	474 398	1 249 055	929 234	283 210
	Organic	1 132 119	4 238 540	15 145 104	11 079 611
TOTAL		**56 739 090**	**92 210 435**	**91 231 020**	**38 682 630**

3.5.2 Agricultural production

3.5.2.1 Total crop production

3.5.2.1.1 Indicator description

This indicator reflects the total annual production of crops, measured in kilotons (kt) per year.

3.5.2.1.2 Scenario results

As productive areas decrease and more extensive (and less productive) systems such as organic production increase in the scenario, we see a reduction in the total annual crop productions, reaching -6% in the Reference scenario, -13% in the current policy scenario, and -27% in the Major Change scenario (Table 31).

Table 31: Evolution of total crop production in the current situation (2018-2022) and the three scenarios (2050), expressed in kt/yr.

Sector	2018 – 2022 Scenario 0 Current situation kt/yr	2050 Scenario 1 Reference kt/yr	2050 Scenario 2 Current policy kt/yr	2050 Scenario 3 Major Change kt/yr
Cereals	2 702	2 457	2 069	1 635
Forage crops	7 900	8 158	7 661	6 383
Fruits	732	725	673	553
Greenhouse vegetables	396	375	368	334
Legumes	25	21	18	16
Oil-rich crops	113	101	83	66
Open-air vegetables	1 445	1 375	1 334	1 213
Pasture	5 056	4 097	4 497	4 215
Potatoes	4 497	4 480	3 829	3 002
Sugar Beet	4 952	4 371	3 660	2 921
Total	**27 816**	**26 159**	**24 192**	**20 338**
Delta vs. current		*-6%*	*-13%*	*-27%*

3.5.2.2 Reared animals

3.5.2.2.1 Indicator description

The values in Table 32 indicate the number of animals reared over one year in Belgium. For certain animal categories (productive pigs and broilers), these values are higher than the livestock populations living at one moment in time in Belgium (as presented in Table 28) as more than one production cycle per year can be performed.

To be noted that the scenario design parameter regarding livestock reduction applies to livestock population at one moment in time. As a result, the evolution of the livestock population might not be exactly the same if compared at one moment in time or over a full year. This can be explained by the hypotheses on the evolution of production systems (e.g., organic) and the different number of cycles per year of different production systems.

3.5.2.2.2 Validation

For comparison and validation purposes, the total number of reared animals can be compared to the annual number of slaughters (Statbel data). Our model results and the Statbel data are well aligned, except for broilers. Indeed, slaughter data indicates close to 300 million slaughtered broilers in 2019 while our data indicates 243 million broilers for that year. The difference could be explained by the fact that many live broilers are being imported and slaughtered in Belgium, as indicated in the meat supply balances.

3.5.2.2.3 Scenario results

In line with the scenario parameters, we observe significant increases in animal production in the Reference (+59%) and Policy (+51%) scenarios, as well as a significant decrease in the Major Change scenario (-42%) (Table 32). These differ from those in Table 28 because the time period considered here is "over a year", whereas Table 28 considers "at one moment".

Table 32: Evolution of livestock animals reared over one year in Belgium in the current situation (2018-2022) and in three scenarios in 2050.

Sector	Product	2018 – 2022 Scenario 0 Current situation	2050 Scenario 1 Reference	2050 Scenario 2 Policy	2050 Scenario 3 Major Change
		heads/year	heads/year	heads/year	heads/year
Bovine meat	Suckler cows	346 997	170 029	170 029	100 629
	Young bulls	145 805	71 444	71 444	42 283
Dairy	Dairy cows	516 577	511 411	511 411	284 117
Eggs	Laying hens	9 124 326	12 956 542	12 956 542	6 569 514
	Reproductive hens	2 429 552	3 449 964	3 449 964	1 749 278
	Young hens	11 031 069	15 664 119	15 664 119	7 942 370
Pork	Productive pigs	10 923 275	9 694 651	7 334 736	3 116 532
	Reproductive pigs	392 343	360 956	274 640	117 703
Poultry	Broilers	243 640 707	399 035 974	380 049 940	140 460 739
Monogastrics		**277 541 272**	**441 162 206**	**419 729 942**	**159 956 136**
Delta vs. current		-	*+59%*	*+51%*	*-42%*
Ruminants		**1 009 378**	**752 884**	**752 884**	**427 030**
Delta vs. current		-	*-25%*	*-25%*	*-58%*
Total		**278 550 651**	**441 915 090**	**420 482 826**	**160 383 166**
Delta vs. current		-	*+59%*	*+51%*	*-42%*

3.5.2.3 Total animal production

3.5.2.3.1 Indicator description

For bovine, pork, and poultry meat, production is expressed in kilotons (kt) of live weight. For dairy products, production is expressed in millions of liters of milk (ML), and for eggs, it is expressed in kilotons of eggs.

3.5.2.3.2 Validation

Total milk production in Belgium according to Belgian Dairy Confederation (CBL-BCZ) reached 4.066 kt in 2019. Initial model results showed an underestimation of total milk production in Flanders. This was due to an underestimation in our model of the milk productivity per cow in Flanders: our model assumed an average productivity of 6.438 L/dairy cow/yr whereas the average productivity according to CBL-BCZ amounted 8.755 L/dairy cow/yr. To correct this, dairy productivity levels for Flemish dairy systems were increased by 36% (correction factor of 1,36). Furthermore, given that such productivity gains cannot be obtained without any modification of practices, we assumed a similar increase in the use of concentrates feed for Flemish dairy systems.

3.5.2.3.3 Scenario results

As expected, production levels align with the parameters defined in the scenario framework (Table 33). The Major Change scenario leads to a significant decrease across all types of production. Conversely, under the Reference and current policy scenarios, milk, egg, and poultry production increases, while pork and beef production declines.

Table 33: Evolution of total animal production in the current situation (2018-2022) and in the three scenarios (2050).

Production	2018-2022	2050					
	S0 Current kt/yr	S1 Reference kt/yr	Delta current %	S2 Current policy kt/yr	Delta current %	S3 Major Change kt/yr	Delta current %
Bovine meat (kt/yr)	188	142	-24%	142	-24%	80	-57%
Milk (ML/yr)	4087	4 392	+7%	4325	+6%	2369	-42%
Eggs (kt/yr)	184	261	+42%	259	+41%	130	-29%
Pork (kt/yr)	847	751	-11%	566	-33%	238	-72%
Poultry (kt/yr)	280	468	+67%	455	+63%	173	-38%

3.5.3 GHG emissions from LULUC

3.5.3.1 Indicator description

This indicator reflects the GHG emissions from land use and land use change associated to Belgian agriculture, expressed in kilotonnes of CO_2 equivalent per year (kt CO_2eq/yr). These emissions are calculated by estimating the emissions occurring on nine LULUC categories. As a first step, the available agricultural land is allocated into these different categories. As a second step, LULUC-specific emission factors allow to estimate the associated emissions.

3.5.3.2 Validation

For validation purposes, emission factors and total emissions of usual LULUC categories (cropland, grassland, forests) are based on and compared against results from the national inventory.

3.5.3.3 Scenario results

Distribution of areas

Figure 26, Table 34 and Table 35 show the allocation of agricultural land into LULUC categories following the scenario hypotheses (Table 18).

While the Reference scenario leads to minor shifts of areas between LULUC categories compared to the current situation, the allocation of land into different categories changes in the Policy and Major Change scenarios. In particular, with regards to cropland and grassland, we see a gradual decrease of land use changes between both categories, shifts from grasslands to croplands are halved in the scenario S2 (around 44 kha/yr vs 90 kha/yr in 2018-

2022) and reach 0 ha in the scenario S3. Shifts from croplands to grasslands are maintained in scenario S2 at around 47 kha/yr while they only represent 7,5 kha/yr in scenario S3.
In parallel, scenario S3 also shows the major increases in terms of biodiversity area as almost 80 kha of new biodiversity area is created under this scenario (on top of the existing areas), while other scenarios maintain the existing 55 kha. Finally, in terms of agroforestry, all scenarios devote some land to implement agroforestry systems, reaching 50 kha in scenario S1, 110 kha in scenario S2, and 206 kha in scenario S3 (Figure 26, Table 34 and Table 35).

Table 34: Distribution of total agricultural area (ha) in different LULUC categories in the current situation (2018-2022) and in different scenarios in 2050, per LULUC category.

LU - level 2	LULUC	2018-2022 S0 – Current situation ha	2050 S1 – Reference ha	2050 S2 – Current policy ha	2050 S3 - Major change ha
Cropland	Cropland remaining cropland	732 366	737 367	720 314	601 631
	Grassland to cropland	90 570	95 585	44 315	0
Grassland	Grassland remaining grassland	410 260	277 880	321 360	288 322
	Cropland to grassland	45 759	50 219	47 241	7563
Existing biodiv	Biodiv on cropland	36 302	36 302	36 302	36 302
	Biodiv on grassland	19 077	19 077	19 077	19 077
New biodiv	Cropland to biodiv	0	0	0	49 622
	Grassland to biodiv	0	0	0	28 432
Agroforestry	Cropland to Agroforestry	0	22 289	42 154	70 881
	Grassland to agroforestry	0	28 149	68 414	134 984
TOTAL		**1 334 333**	**1 266 868**	**1 299 177**	**1 236 813**

Table 35 : Distribution of total agricultural area (ha) in different LU categories in the current situation (2018-2022) and in different scenarios in 2050, per LU category.

LU – level 1	LU - level 2	2018-2022 S0 Current situation ha	2050 S1 Reference ha	2050 S2 Current policy ha	2050 S3 Major change ha
Agricultural area	Cropland	822 935	832 951	764 629	601 631
	Grassland	456 019	328 099	368 601	295 884
Biodiversity area	Existing biodiv	55 379	55 379	55 379	55 379
	New biodiv	0	0	0	78 054
Agroforestry	Agroforestry	0	50 438	110 568	205 865
TOTAL		**1 334 333**	**1 266 868**	**1 299 177**	**1 236 813**

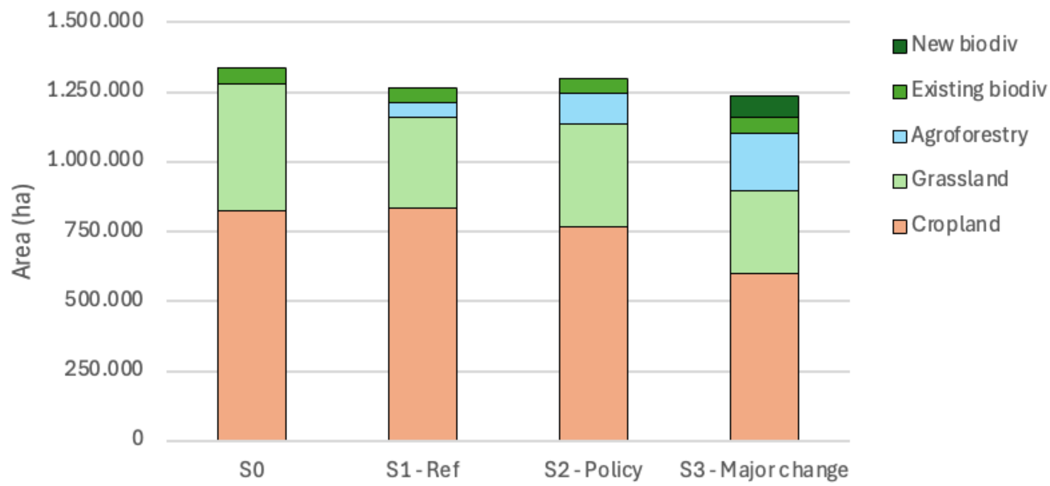


Figure 26: Allocation of agricultural land into different land use categories in the current situation (S0, 2018-2022) and in three scenarios towards 2050.

The following paragraphs highlight the evolution of GHG emissions per LULUC category in the different scenarios. All results are summarized in Table 36 and Table 37.

Emissions from cropland and grassland
Regarding croplands, their emissions remain rather constant at around 800 kt CO_2eq/yr in the Reference scenario (S1). Cropland emissions decrease to 541 kt CO_2eq/yr in the Current policy scenario (S2) and to 251 kt CO_2eq/yr in the Major Change scenario (S3), i.e. nearly a 70% decrease compared to the current situation (Table 36 and Table 37). The evolutions shown in scenarios S2 and S3 are the result of a reduced cropland area on one hand, and of the decrease conversion of grasslands into croplands on the other hand (which is halved in scenario S2 compared to the current situation, and reaches 0 ha/year in scenario S3, as described above).

Regarding grasslands, both the Reference scenario (S1) and the Current policy scenario (S2) lead to minor changes compared to the current situation, with emissions levels situated at around -200 kt CO_2eq/yr (i.e. a net sequestration). This sequestration effect is mainly the result of the conversion of cropland into grasslands. As these conversions are greatly decreased in the Major Change scenario (S3), so does the sequestration potential of that scenario. Overall, grasslands become (slightly) net emitters in that scenario, with 14 kt CO_2eq/yr in 2050 (Table 36 and Table 37). This result can nevertheless be nuanced by the fact that some grasslands and croplands are reallocated to biodiversity and agroforestry areas, especially in scenario S3 (see sections below). These conversions enable substantial CO_2eq sequestration. Consequently, croplands and grasslands could theoretically appear as net carbon sinks if these converted areas remained counted under their original land-use categories. When they are instead reclassified as “biodiversity areas” or “agroforestry areas”, the carbon benefits they generate are no longer attributed to croplands and grasslands, which is why these categories continue to appear as sources rather than sinks.

Carbon sequestration in biodiversity areas
Here we consider the net emissions arising on biodiversity areas, both existing and newly created. As a reminder, these areas are considered at the interface between grasslands and

forests (see §3.2.5.1.4), leading to a net sequestration potential for these areas (EF_bb = -889 kg CO_2eq/ha/yr ; see Table 20).

In the current situation, 4.8% of arable land in Flanders and 3.6% in Wallonia are allocated to biodiversity, representing a total of 55 kha. While these areas are maintained in scenarios S1 and S2, scenario S3 sets aside an additional 78 kha of land for biodiversity conservation, resulting in a total of 132 kha in that scenario. As a result, the sequestration potential of these areas, estimated at -49 kt CO_2eq/yr in the current situation, is maintained in scenarios S1 and S2. It more than doubles in scenario S3 as it increases to -119 kt CO_2eq/yr in that scenario (Table 36 and Table 37).

Carbon sequestration by the implementation of agroforestry
The final land use category considers the net emissions arising on land where agroforestry systems are implemented. To estimate these emissions, we rely on three possible emission factors, including a conservative hypothesis, an intermediate hypothesis, and an optimistic hypothesis, leading to a sequestration potential comprised between -4525 kg CO_2eq/ha/yr and -10 083 kg CO_2eq/ha/yr (Table 21).

We consider the area of agroforestry to be zero in the current situation, with no sequestration potential from those systems as a result. In scenarios S1 and S2, agroforestry systems are implemented on around 5% and 10% respectively, representing around 50 and 110 kha respectively. This comes with a sequestration potential of -295 kt CO_2eq/yr for scenario S1 and -646 kt CO_2eq/yr for scenario S2 under the intermediate sequestration hypothesis. In scenario S3, the land devoted to agroforestry systems reaches over 200 kha, with a sequestration potential of -1203 kt CO_2eq/yr (Table 36 and Table 37). Considering the range of alternative hypotheses, we can assume that the sequestration potential of agroforestry is comprised between -456 kt CO_2eq/yr (conservative emission factor with least ambitious agroforestry implementation, i.e. scenario S1) and -2076 kt CO_2eq/yr (optimistic emission factor with most ambitious agroforestry implementation, i.e. scenario S3)

As a sidenote, it is interesting to consider the impact on production resulting from the loss of agricultural land. As explained in earlier sections (see §3.2.5.1.5), we assume a 12% reduction in productive area (on both cropland and grassland) where agroforestry is implemented, representing the land taken up by tree rows. Under the most ambitious scenario (S3), agroforestry is implemented on around 200 kha, thus leading to a loss of around 25 kha, i.e. less than 2% of current agricultural land. We thus assume that the impact on the production of biomass resulting from the implementation of agroforestry will remain limited, even more so since these 25 kha also lead to a production of biomass through the trees (e.g. firewood, timber, fruits, etc.).

Combined sequestration through biodiversity areas and agroforestry
All in all, considering the combination of hypotheses set on the different LULUC categories, the scenarios show significant differences in the net LULUC emissions related of the Belgian agriculture sector. While the current situation (S0) results in net emissions of 578 kt CO_2eq/yr, all scenarios show a reduction of emissions. On one side, scenario S1 halves these levels but continues to lead to net emissions (263 kt CO_2eq/yr). On the other side, scenarios S2 and S3 lead to a net sequestration potential, which increases through scenarios S2 and S3. The Current policy scenario and the Major Change scenario showcase important sequestration potentials, reaching -350 kt CO_2eq/yr in Scenario S2 and -1057 kt CO_2eq/year in scenario S3.

Agroforestry plays an important role in reaching a net sequestration situation as all three scenarios would remain net emitters without agroforestry systems, with nevertheless decreasing emissions between scenario S1 (558 kt CO_2eq/yr), scenario S2 (296 kt CO_2eq/yr) and scenario S3 (146 kt CO_2eq/yr). These results consider an intermediate emission factor for agroforestry. Taking the conservative and optimistic emission factors would not affect the status of the scenarios as either sinks or sources: scenarios S2 and S3 would maintain a sequestration potential under a conservative hypothesis (respectively –204 and –785 kt CO_2eq/yr), while scenario S1 would remain a net emitter under the optimistic hypothesis (+49 kt CO_2eq/yr).

These results highlight the significant range and inherent uncertainty associated to estimating the impacts of alternative LULUC practices. This situation is observed not only between scenarios, because of the different scenario hypotheses, but also within scenarios, due to the important uncertainty associated with emission factors, particularly those related to agroforestry.

Two alternative agricultural land use practices: biodiversity areas and agroforestry

In this study, agroforestry and biodiversity areas are considered as two alternative land use practices besides agricultural usual land uses (croplands and grasslands). In this report and in the calculations presented above, these two alternative land uses are presented as independent although complementary, both to each other but also to other practices and systems such as organic farming. Each of those "systems" - biodiversity area, agroforestry, organic farming- bring their own benefits and contribution to the reduction of carbon emission, which we detail below.

Biodiversity land areas

Belgium has a national biodiversity strategy[7] with specific objectives and targets. The objective of this strategy specifically tackles the sustainable use of biodiversity components in economic sectors (agriculture, sylviculture, tourism etc.). For agriculture, the objective is to have farmers engaging on sustainable paths and committing to various actions. These commitments cover a wide range of activities, such as preserving multi-annual grasslands, establishing flower strips, mechanical weed control, maintaining small landscape features such as hedges, or converting to and maintaining organic farming. It covers, therefore, a wide range of practices that go beyond agroforestry practices.

Agroforestry

Agroforestry is defined as "a set of diverse land management systems that integrate trees and shrubs with crops and/or livestock in space and/or time. Agroforestry accumulates carbon in woody vegetation and soil" (IPCC, 2022). An agroforestry system will be set up to perform several functions. The most common are (i) soil protection, (ii) water protection, (iii) climate buffering, (iv) protection of biodiversity and agroecosystems, (v) air purification, (vi) protection and integration of buildings, and (vii) socio-economic benefits. Therefore, the protection of biodiversity is not the sole objective of the practices, and its impact will depend on the chosen species and management.

Complementarity

In the scenarios presented above, agroforestry and biodiversity areas have been implemented separately. Yet, constitutive elements of agroforestry (tree rows, hedges…) can also be found

[7] https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/mise_a_jour_de_la_strategie_nationale_belge_pour_la_biodiversite_a_lhorizon_de_2030.pdf

in biodiversity areas, leading us to wonder about the similarities, synergies and general complementarity of both strategies. While they indeed show similarities in terms of land use practices and elements, our assumption is that both strategies will not be implemented similarly in different areas. As biodiversity areas are more integrated into the productive landscape, they might be easier to implement as "isolated" elements (e.g. isolated trees, hedges along a field) where competition for land is more important such as in the cropland regions. On the other hand, agroforestry systems might be easier to set up in areas where land is more readily available, e.g. on grassland areas in Southern Wallonia. Thus, while both strategies show similarities in terms of practices, resorting to one or the other might facilitate tailoring the proposed land use practices to local context and geographic areas (which has not been done in the context of this study which takes Belgium as a unit of analysis rather than being spatially disaggregated at a finer scale).

Table 36 : Evolution of emissions from LULUC associated to agriculture in the current situation (2018-2022) and in foresight scenarios in 2050 (kt CO_2eq/yr), per LULUC category.

LU - level 2	LULUC	2018-2022 S0 Current	2050 S1 Reference	2050 S2 Policy	2050 S3 Major change
Cropland	Cropland remaining cropland	305	308	300	251
	Grassland to cropland	492	520	241	0
Grassland	Grassland remaining grassland	79	53	62	55
	Cropland to grassland	-250	-274	-258	-41
Biodiversity	Existing biodiversity	-49	-49	-49	-49
	New biodiversity	0	0	0	-69
Agroforestry	Cropland to Agroforestry	0	-130	-246	-414
	Grassland to agroforestry	0	-165	-400	-789
TOTAL		**578**	**263**	**-350**	**-1057**
	With optimistic agroforestry EF	*578*	*49*	*-819*	*-1929*
	With conservative agroforestry EF	*578*	*329*	*-204*	*-785*

Table 37 : Evolution of emissions from LULUC associated to agriculture in the current situation (2018-2022) and in foresight scenarios in 2050 (kt CO_2eq/yr), per LU category.

LU - level 1	LU - level 2	2018-2022 S0 Current	2050 S1 Reference	2050 S2 Policy	2050 S3 Major change
Agricultural area	Cropland	798	827	541	251
	Grassland	-171	-220	-196	14
Biodiversity area	Existing biodiversity	-49	-49	-49	-49
	New biodiversity	0	0	0	-69
Agroforestry	Agroforestry	0	-295	-646	-1203
TOTAL		**578**	**263**	**-350**	**-1057**
	With optimistic agroforestry EF	*578*	*49*	*-819*	*-1929*
	With conservative agroforestry EF	*578*	*329*	*-204*	*-785*

3.5.4 GHG emissions from agriculture

3.5.4.1 Indicator description

The agriculture-related LULUC emissions presented above, as they are derived from NIR data, are relatively coarse as they do not allow for any distinction between crop types or production systems. To account for the impact of agricultural practices, this indicator reflects the GHG emissions linked to Belgian agricultural production (crop and livestock), expressed in kilotonnes of CO_2 equivalent per year (kt CO_2eq/yr). The assessment includes three distinct emission sources (Table 38), which are also included in the NIR but attributed to the agriculture sector. Two are specific to the livestock sector: enteric fermentation and manure management, and one is specific to the crop sector: organic synthetic N fertilization.

Table 38: Scope of assessment of GHG emissions: emission sources, target sector and comparison with scope of national inventory report.

Emission sources	Target sectors	Scope of NIR
Enteric fermentation	Animal sectors	Agriculture sector
Manure management	Animal sectors	Agriculture sector
Organic and synthetic N fertilization	Plant-based sectors	Agriculture sector

3.5.4.2 Validation

For validation purposes, model results are compared against data from the national inventory report (NIR, 2021).

3.5.4.3 Scenario results

All scenarios lead to reductions in total GHG emissions. The reference scenarios and the Current policy scenario will be characterized by reductions of -22% and -26% respectively, while the Major Change scenario leads to more significant reductions of -56% (Table 39).

Overall, the relative contributions of each emission source remain consistent across scenarios. However, a closer look will reveal notable variations across scenarios. In particular, the share of plant-based vs. animal-based emissions evolves. While animal productions represent around 75% of emissions in scenarios S0, S1 and S2, this share drops to around 66% in Scenario S3. This can be seen in drastic reductions in enteric fermentation and manure management in this scenario as a result of significant reductions in all types of livestock.

Concerning synthetic nitrogen fertilization, the growing share of organic farming systems leads to substantial emission reductions: -23% in the Reference scenario and up to -63% in the Major Change scenario. In contrast, emissions from organic nitrogen fertilization remain relatively stable across the scenarios. This apparent stagnation results from two counterbalancing trends: a decrease in the total UAA and a simultaneous expansion of organic farming.

These results highlight the important weight of animal productions in the GHG emissions of the Belgian agriculture sector, and that reducing the size of the animal herd can have a significant positive impact on the sector's emission. While other emission sources could be included in these calculations (e.g. on-farm energy use, production from imported feed, production of synthetic inputs such as fertilizers and pesticides), their inclusion is unlikely to considerably alter the relative importance of animal productions.

Table 39: Evolution of GHG emissions from the Belgian agricultural sector in the current situation (2018-2022) and three scenarios in 2050 (kt CO_2eq/yr).

Emission source	**2018-2022 S0 Current** kt CO_2eq/yr	**2050 S1 Reference** kt CO_2eq/yr	**2050 S2 Current policy** kt CO_2eq/yr	**2050 S3 Major change** kt CO_2eq/yr
Enteric fermentation	3071	2247	2210	1230
Manure management	1891	1543	1372	625
Crop fertilization - Synthetic N	684	524	364	256
Crop fertilization - Organic N	725	679	759	707
TOTAL	**6372**	**4993**	**4706**	**2817**
Delta vs. current	-	*-22%*	*-26%*	*-56%*
Share animal-based	*78%*	*76%*	*76%*	*66%*
Share plant-based	*22%*	*24%*	*24%*	*34%*

It should be noted that, given the narrower scope of this study (see section 3.2. Methodology) compared to that of the NIR, slight differences may be observed. In contrast to the NIR, emissions are calculated exclusively for productive land and animals, thereby excluding calves, heifers, and similar categories. Additionally, the model does not account for emissions related to liming and urea, nor emissions associated with crop residues. Accounting for these additional emissions sources would thus increase the total GHG emissions of the Belgian agricultural sector. Importantly, the LULUC emissions from the sector, and the potential sequestration observed in scenarios S2 and S3 are not sufficient to compensate and offset agricultural emissions.

3.5.5 Biodiversity impact

3.5.5.1 Indicator description

The biodiversity impact indicator reflects an estimated species loss (expressed as a 'damage score') resulting from agricultural production. Different land-use types—such as croplands and grasslands—and land management intensities (minimal, light, or intense use) lead to different impacts, with specific characterization factors for Belgium proposed by Chaudhary and Brooks

(2018). We consider four distinct land use types: arable land, temporary pasture, permanent pasture and biodiversity areas (Table 22).

3.5.5.2 Scenario results

As shown in Table 40, arable land is the greatest contributor to biodiversity impact in terms of potential species loss, followed by permanent pastures, which have lower impact levels per unit of area. Overall, the impact on biodiversity decreases in the scenarios, with the Major Change scenario leading to the greatest reduction (-14% vs. -5% in Reference and Current policy scenarios). This is mainly the result of the greater share of agricultural land set aside for biodiversity conservation and the greater share of organic agriculture in this scenario.

While this indicators and the associated results may be difficult to translate into on-the ground measurements and practical measures, the purpose is to asses a relative change compared to the current situation, and to acknowledge that agricultural practices have an impact on biodiversity which can hardly be taken down to zero (a damage score of 0 would show no impact on biodiversity).

Table 40: Biodiversity impact (Damage Score) of different land uses in the current situation (2018-2022) and three scenarios in 2050.

Parameter	**2018-2022**	**2050**		
	Scenario 0 Current situation	**Scenario 1 Reference**	**Scenario 2 Current policy**	**Scenario 3 Major Change**
Arable land	0.070	0.072	0.068	0.057
Temporary pasture	0.009	0.009	0.008	0.007
Permanent pasture	0.038	0.030	0.035	0.034
Biodiversity (extensive grasslands)	0.002	0.002	0.002	0.005
Total Biodiversity impact	**0.119**	**0.113**	**0.113**	**0.102**
Delta vs. current		*-5%*	*-5%*	*-14%*

3.5.6 Climate change adaptation

This section provides a brief qualitative analysis of how the agricultural practices mobilized in the scenario modelling may contribute to improving the resilience of agricultural systems to climate change, i.e., their ability to better adapt to future climatic conditions.

Adaptation strategies refer to practices aimed at anticipating, managing, and minimizing the current and future impacts of climate change (Smit & Skinner, 2002; IPCC, 2014; Pisante, et al., 2015). In Belgium, climate projections depend on the Representative Concentration Pathways (RCPs). Under the high-emission scenario RCP8.5, average temperatures are projected to rise between 2.6°C and 3.5°C by 2100, compared to the early 21st century baseline (Termonia, et al., 2018). Moreover, precipitation seasonality is expected to intensify, with a likely increase in winter rainfall (low uncertainty) and a probable decrease in summer rainfall (high uncertainty) by the end of the century (AWAC, 2011; de Frutos Cachorro, et al., 2018; Plateforme Wallonne pour le GIEC, 2020). Understanding how land management practices can enhance resilience under these future climate conditions is thus essential for shaping robust adaptation strategies.

3.5.6.1 Grasslands

Preserving grasslands constitutes an adaptation strategy to enhance agricultural resilience in the face of climate change. To support their resilience, climate-responsive management practices, the use of robust forage species, and improved water management have been recommended (Putra, et al., 2025). Beyond climate adaptation, grasslands provide essential ecosystem services, including biodiversity conservation—both floral (with up to 15 – 40 plant species per grassland) and faunal (refuge and food sources for birds, earthworms (Liu, et al., 2025), pollinators, and small mammals)—and water regulation (Celagri, 2021). Grasslands significantly reduce erosion and nitrate leaching by promoting water infiltration and limiting runoff, with soil loss rates estimated to be over ten times lower than those of arable land (Cerdan, et al., 2010; Celagri, 2021).

Despite these benefits, two of the three scenarios explored in this study ("Reference" and "Policy") predict a decrease in grassland area compared to the current situation (−21% and −4%, respectively). Only the "Major Change" scenario maintains and slightly increases current grassland areas (+1%). Given the mounting scientific evidence, maintaining—if not expanding—grassland cover appears essential not only to prevent additional CO_2 emissions from grassland-to-cropland conversion but also to preserve biodiversity and mitigate erosion risks.

3.5.6.2 Organic farming

Organic farming emerges as another promising strategy to enhance the resilience of agricultural systems under climate change. Although organic farms generally achieve lower yields compared to conventional systems, they tend to be more profitable- at the farm level- and environmentally sustainable (Smith, et al., 2020). Numerous studies have demonstrated that organic farming enhances biodiversity (Kennedy, et al., 2013; Lichtenberg, et al., 2017), supports pollinator abundance and diversity, and strengthens natural pest control (Muneret, et al., 2018). These benefits contribute to greater agroecosystem stability, making organic systems better equipped to withstand climatic extremes and ecological disturbances. In addition, organic farming practices—by the application of organic fertilizers—promote SOC accumulation, which enhances soil structure, water retention, and resistance to erosion and runoff. This improved soil quality is a key factor in building long-term resilience to droughts and heavy rainfall events.

All three scenarios modelled in this study foresee an increase in the share of organic farming compared to the current situation, ranging from 1.6% to 40% in Flanders and from 13% to 60% in Wallonia. By increasing the share of organic farming, each scenario contributes to biodiversity preservation, soil improvement, and a reduction in pesticide use—and thereby in associated GHG emissions—reinforcing the sector's adaptive capacity in the face of climate challenges.

3.5.6.3 Carbon farming

Carbon farming encompasses a set of agricultural practices designed to increase carbon sequestration while enhancing the resilience of agroecosystems to climate change. These include restoring peatlands and wetlands, integrating trees into agricultural systems (agroforestry), applying conservation agriculture techniques (e.g., cover crops, reduced tillage, hedgerows), reforesting with biodiversity-friendly species, and optimizing fertilizer use (European Commission, 2025). Among these, agroforestry stands out as the most impactful measure for both mitigation and adaptation (Aertsens, et al., 2013; Rubio-Delgado, et al., 2025). It not only significantly enhances carbon storage, but also moderates microclimatic extremes, buffers heat stress, and improves overall yield stability. Agroforestry systems typically achieve higher combined productivity than monocultures of trees or crops alone and support biodiversity and sustainable land use (Giannitsopoulos, et al., 2025).

In our study, agroforestry was selected as the representative carbon farming strategy, given its high potential for offsetting emissions from livestock, crop production, and land-use change. It was modelled in order to discuss its transformative capacity to turn agriculture into a net carbon sink.

However, this direction would require specific political support. As of today, agroforestry remains indeed marginal in Belgium, and recent trends show a 36% decline in agroforestry area between 2012 and 2022, mainly due to the intensification of cropping systems and the abandonment of grazed land (Rubio-Delgado, et al., 2025). This gap between theoretical potential and actual implementation underscores the need for supportive policy frameworks to scale up agroforestry and other carbon farming practices.

3.5.6.4 Recommendations for Strengthening the Scenarios

Beyond the agricultural practices explored in this study, we wish to highlight two additional strategies that could further enhance carbon sequestration, mitigate agricultural emissions, and improve the sector's adaptive capacity to climate change: cover cropping and the addition of organic matter.

Covering soils with living plants throughout the year—through cover crops, catch crops, or undersown grasses—offers multiple benefits. It stimulates soil biology, promotes carbon storage, and supports the development of a stable soil structure, which enhances both water infiltration and retention. These benefits are particularly valuable in the context of increasing climate extremes, as healthier soils improve resilience to droughts and floods.
Similarly, adding organic matter, such as compost or manure, plays a crucial role in long-term soil fertility and structure, which contribute to higher SOC stocks and more resilient farming systems (Garre, 2021; Torrús Castillo, et al., 2025).

By integrating these practices—alongside agroforestry, permanent grassland preservation, and organic farming—future scenarios could offer a more comprehensive response to the dual challenge of climate change mitigation and adaptation.

3.6 Conclusion and key takeaways

3.6.1 Conclusion

The second part of the project analyzed the agricultural sector with the objective of quantifying the potential for natural carbon sequestration through agricultural practices in Belgium. Specifically, the objective of this study is to evaluate the potential for modifying land use and management practices to reduce GHG emissions and increase the capacity of Belgian agricultural land to absorb atmospheric CO_2.

Three scenarios for 2050 (S1, S2 and S3) were studied and compared with the current situation for the period 2018-2022 (S0). These three scenarios represent increasing levels of transformation, ranging from a business-as-usual pathway (S1: "Reference") to a highly transformative pathway (S3: "Major Change"), with an intermediate policy-driven scenario (S2: "Current policy"). Given the strong influence of agroforestry on carbon sequestration potential, results for each scenario are presented both with and without the implementation of agroforestry practices.

Under the current situation (2018-2022, S0), emissions related to agricultural land use and land-use change (covering grasslands, croplands, and agricultural land dedicated to biodiversity) are estimated at 578 kt CO_2eq/yr. This value serves as the reference point against which all alternative scenarios in 2050 are compared.

Scenario S1 extrapolates current trends to 2050. As expected, it shows only marginal differences compared to the current situation (S0). Without agroforestry, LULUC emissions of S1 amount to 558 kt CO_2eq/yr in 2050, remaining close to the 2018-2022 situation (S0). When agroforestry practices are introduced on 2.5% of cropland and 7.5% of grassland, emissions are reduced by approximately half, reaching 263 kt CO_2eq/yr in 2050.

Scenario S2 reflects the implementation of existing Belgian policies that affect carbon sinks and land-use dynamics in 2050. Compared to S1, cropland-related emissions are reduced by roughly half. This reduction is primarily driven by a decrease in total cropland area and a lower rate of conversion from grassland to cropland. With the implementation of agroforestry on 5% of cropland and 15% of grassland, the LULUC balance becomes negative. Under these conditions, the agricultural land acts as a net carbon sink, with an estimated sequestration of –350 kt CO_2eq/yr in 2050.

Scenario S3 represents the most transformative scenario for 2050. It combines a strong reduction in cropland area, a complete halt to the conversion of grassland to cropland, the introduction of new biodiversity areas, and a more ambitious deployment of agroforestry compared to S1 and S2. Without agroforestry, LULUC emissions amount to 146 kt CO_2eq/yr in 2050, corresponding to an almost 70% reduction in cropland-related emissions compared to the current situation (S0). This decrease results from both the continued decline in cropland area and the elimination of grassland-to-cropland conversion. In contrast to S1 and S2, grasslands in S3 are no longer considered a net carbon sink. This is due to the reduced conversion of cropland to grassland, which limits additional sequestration potential from newly established grasslands. However, biodiversity and agroforestry areas, which contribute to carbon sequestration, are implemented on part of both cropland and grassland areas. When agroforestry is implemented on 10% of cropland and 30% of grassland, the LULUC balance shifts considerably. Under this configuration, the scenario becomes a net carbon sink, with a net sequestration potential reaching –1057 kt CO_2eq/yr.

These results underscore the pivotal role of agroforestry in achieving net sequestration, as all three scenarios would remain net emitters without agroforestry systems.

To complement the analysis of land-use emissions, the scope was broadened to assess the impact of expanding organic farming and reducing livestock production on agricultural GHG emissions. Four emission sources were considered: enteric fermentation, manure management, synthetic nitrogen fertilization, and organic nitrogen fertilization. Across all scenarios, agricultural GHG emissions in 2050 decrease, ranging from –22% in S1 to –26% in S2 and –56% in S3 relative to 2018-2022. In S3, converting agricultural land to organic farming reduces fertilizer-related emissions by 32%, while reducing livestock numbers leads to a 63% decrease in livestock emissions. Given the assumed variables, these results highlight the dominant contribution of animal production to agricultural GHG emissions.

Even under the most transformative scenario (S3), carbon sequestration from agricultural land use (–1057 kt CO_2eq/yr with intermediate agroforestry assumptions, or –1929 kt CO_2eq/yr under an optimistic hypothesis) remains insufficient to fully offset the remaining agricultural emissions considered here (2817 kt CO_2eq/yr).

Finally, regarding the impact on biodiversity, estimated by an indicator reflecting the estimated species loss, the impact on biodiversity decreases most significantly in the S3 scenario compared to S0 (-14% vs -5% in S1 and S2), primarily due to the greater share of agricultural land set aside for biodiversity conservation and the greater share of organic agriculture in this scenario (Table 40).

3.6.2 Key takeaways

The results of this study identify two main levers for reducing GHG emissions and increasing carbon sequestration from agricultural land use.

First, changes in land-use dynamics play a central role. Halting the conversion of grassland to cropland and reducing total cropland area improve the LULUC balance. Such changes have implications on the crops being grown in Belgium, in particular crops primarily dedicated to export markets, such as potatoes; in Belgium, for example, production exceeds domestic consumption by a factor of six.

Second, changes in agricultural practices offer significant mitigation potential. Agroforestry emerges as the most effective land-based strategy for reducing net emissions from agricultural soils.

However, the sequestration potential of such practices remains uncertain. Furthermore, even under highly ambitious assumptions for agroforestry deployment (10% of cropland and 30% of grassland in S3), land-use sequestration alone cannot fully offset agricultural-sector emissions.

Significant decreases in animal production are required to achieve deeper emission reductions. Modelling shows that reducing herd size is an effective way of lowering total agricultural GHG emissions. These reductions can be further enhanced by agricultural measures targeting additional sources of agricultural emissions, such as those related to liming, crop residues, pesticide use, animal feed production, etc., which were not included in the scope of this research.

Finally, it is essential to acknowledge the structural limits and conditions associated with land-based carbon sequestration, beyond its mitigation potential. Carbon sequestration is not unlimited: the rate of carbon accumulation declines over time as soils approach a new equilibrium, eventually reaching a saturation plateau. Moreover, soil carbon sequestration is a reversible process and, as such, inherently sensitive to changes in management practices. Sustaining the associated climate benefits requires long-term policy support—including communication, incentives, and monitoring frameworks—to ensure effective and long-term implementation of these practices.

4 PART 3 – SPECIFIC ANALYSIS ON FORESTS

4.1 Belgian Forest Distribution, Composition, Tenure and Management Practices

4.1.1 Forest Distribution

Belgium's forests cover 710 kha according to the Belgian interregional Environment Agency (CELINE-IRCEL), representing 20.6% of the national territory in 2022. This forest area is distributed unevenly across regions: Wallonia holds 535 kha, Flanders contains 172 kha, and Brussels maintains 2 kha (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). These figures from the National Inventory Document for greenhouse gas emissions are slightly higher than alternative estimates from Filière Bois Wallonie (Fillière Bois Wallonie, 2024) for 2023, which report 700 kha nationally, 557 kha in Wallonia, 140 kha in Flanders, and 2 kha in Brussels. For consistency throughout this document, the CELINE-IRCEL values serve as the baseline for all calculations.

Table 41: Forest cover metrics in Belgium

Region	Forest cover (CELINE-IRCEL 2025)	Forest cover (Filière Bois Wallonie 2024)	% of Belgian forest cover (CELINE-IRCEL 2025)	Variation 2000-2022 (Zhang et al. 2024)	Variation 2000-2024 (CELINE-IRCEL 2025)
Belgium	710 kha	700 kha	100.0%	-1.8%	+1.05%
Wallonia	535 kha	557 kha	75.4%	-1.3%	-
Flanders	172 kha	140 kha	24.3%	-3.2%	-
Brussels	2 kha	2 kha	0.3%	-4.2%	-

Forest cover in Belgium has remained relatively stable over recent decades. According to Zhang et al. data (2024), the total forest cover has decreased by less than 2% between 2000 and 2022, while, according to National Inventory Document of Belgium’s greenhouse gas inventory, total forest cover has increased by 1.05% between 2000 and 2024 (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Regionally, certain variations can be observed, with Flanders experiencing higher loss rates at -3.2% compared to Wallonia's -1.3% (Zhang, et al., 2024).

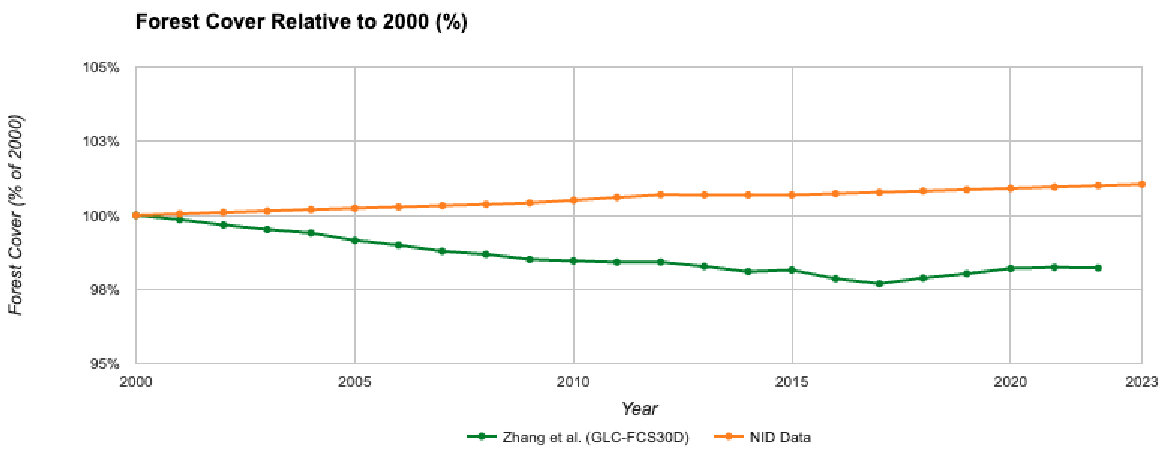


Figure 27: Forest cover in Belgium as a percentage of the cover in 2020 (Zhang, et al., 2024).

This apparent stability at national and regional scales masks significant historical transformations at the stand level. Long-term data reveals substantial forest losses since the late 18th century, with Wallonia retaining only 44% of its original forest cover not cleared or converted to coniferous plantations (Direction de l'état environnemental (DEE), 2024). The impact has been even more pronounced in Flanders, where only 16% of current forests qualify as ancient woodland with continuous cover dating back to 1775 (De Keersmaeker, et al., 2014; Hermy, et al., 2008) highlighting the extensive historical exploitation of Belgium's forest landscape.

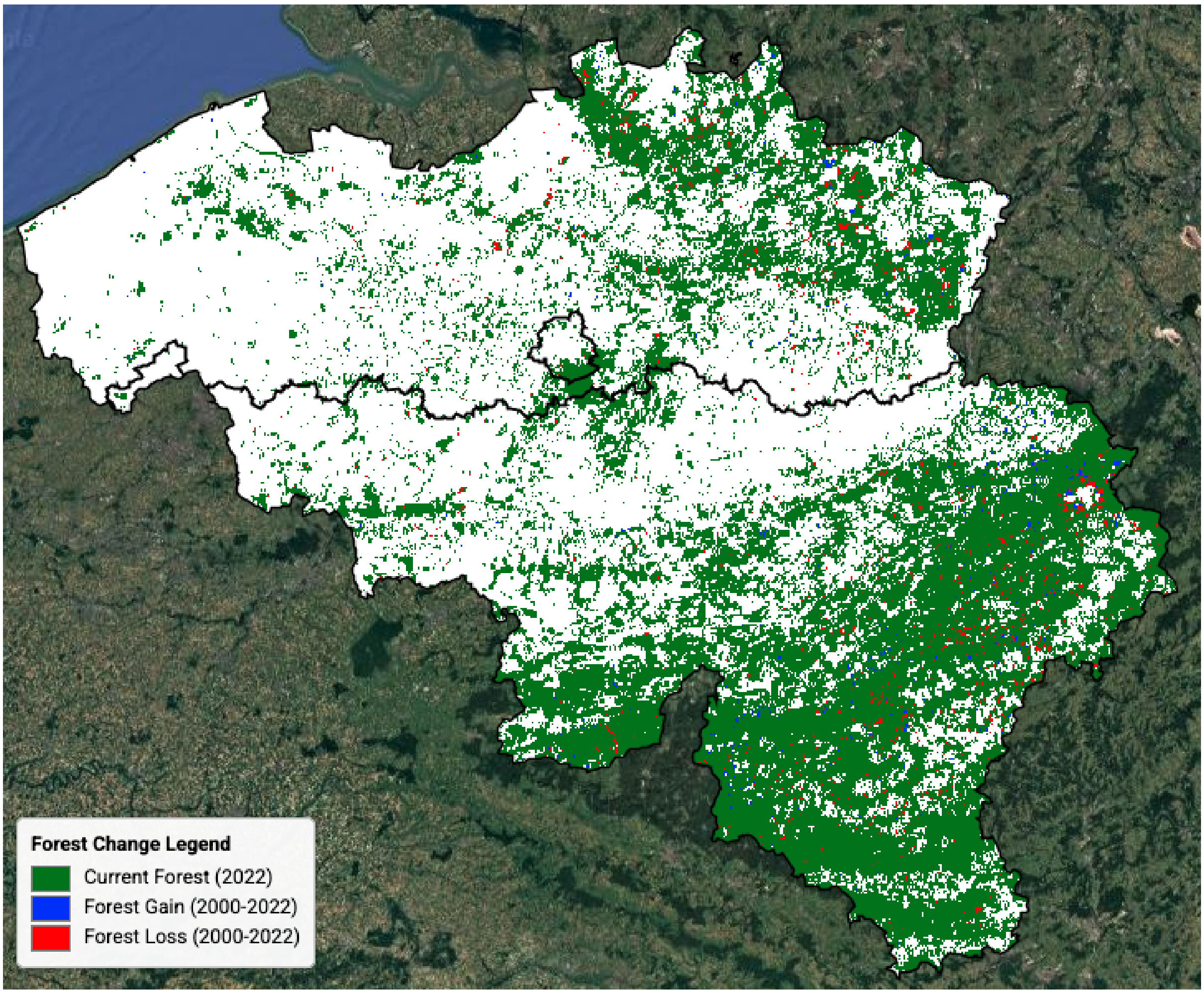


Figure 28: Spatial distribution of forest cover in Belgium (2022) and forest gain/loss patterns during 2000-2022 (Zhang, et al., 2024).

4.1.2 Forest Composition

Belgian forests comprise 59% predominantly deciduous and 41% predominantly coniferous forest, though regional composition varies significantly. Wallonia's forests are 56% deciduous, while Flanders shows a higher deciduous proportion at 64%. Brussels is predominantly deciduous, with deciduous trees accounting for 98% of its forest cover (Fillière Bois Wallonie, 2024).

Table 42: Percentage of predominantly deciduous and coniferous forest in Belgium.

Region	Deciduous	Coniferous	Data Source
Belgium	59%	41%	Filière Bois Wallonie (2024)
	59.2%	40.4%	Zhang et al. (2024)
Wallonia	56%	44%	Filière Bois Wallonie (2024)
	59.7%	40.0%	Zhang et al. (2024)
Flanders	64%	36%	Filière Bois Wallonie (2024)
	57.5%	41.7%	Zhang et al. (2024)
Brussels	98%	2%	Filière Bois Wallonie (2024)
	74.1%	25.5%	Zhang et al. (2024)

These proportions are corroborated by the GLC-FCS30D Annual Land Cover Database for 2022 (Zhang, et al., 2024). The satellite-derived data show Belgium with 59.2% deciduous and 40.4% coniferous forest—nearly identical to the Filière Bois Wallonie figures. Regional breakdowns reveal Wallonia at 59.7% deciduous and 40.0% coniferous, while Flanders shows 57.5% deciduous and 41.7% coniferous. Brussels, represented predominantly by the Sonian Forest, registers 74.1% deciduous and 25.5% coniferous coverage—lower than Filière Bois Wallonie's 98% estimate but still predominantly deciduous. Finally, since 2010, coniferous forests seem to have been decreasing in favor of deciduous forests, reflecting ongoing shifts in forest management and composition.

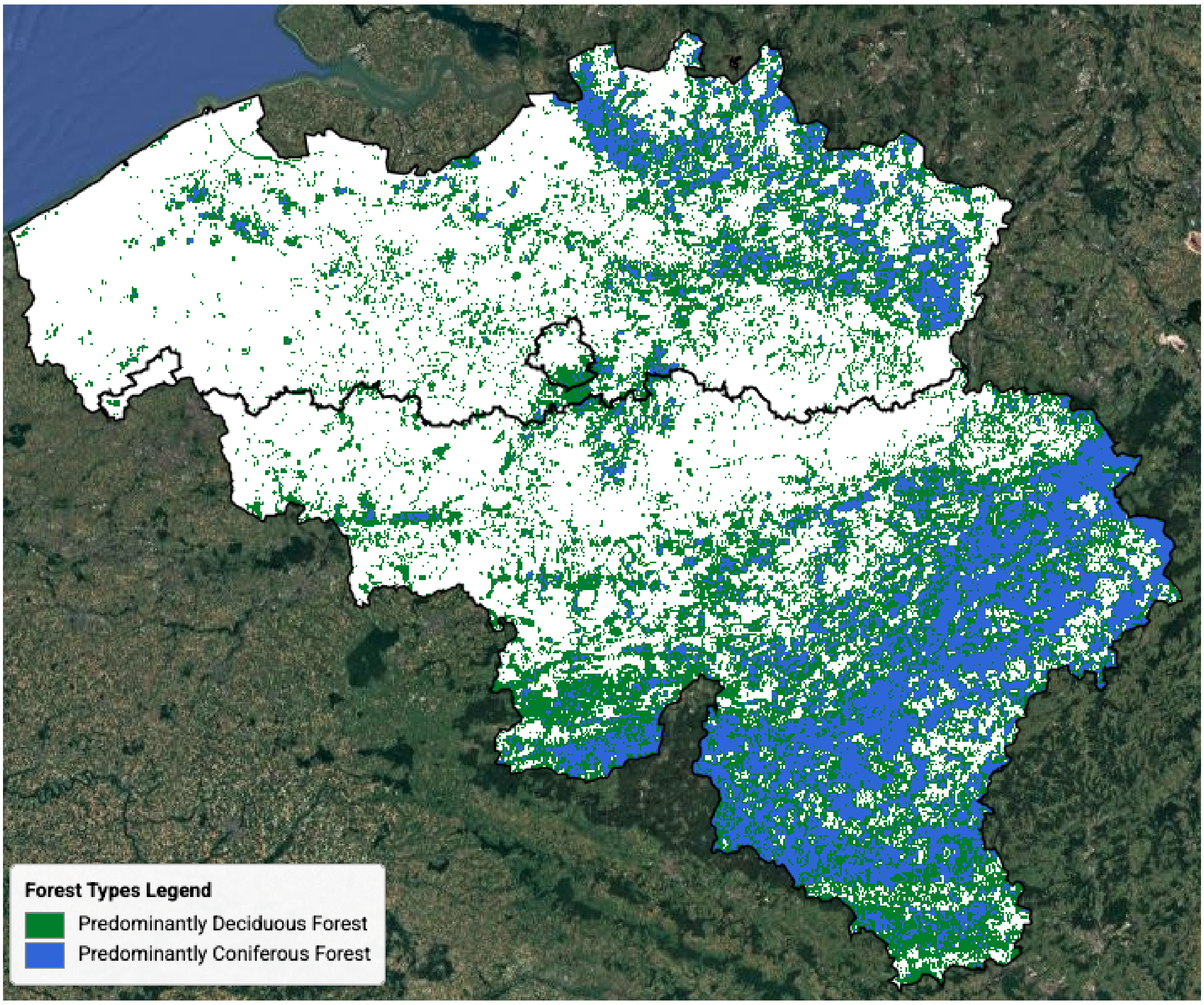


Figure 29: Spatial distribution of forest types in Belgium (2022) (Zhang, et al., 2024).

In Wallonia, spruce forests lead by surface area at 24.6%, followed by oak forests (16.5%), beech forests (9.3%) (Fillière Bois Wallonie, 2024). In Flanders, forest inventory data from 2014-2023 shows Scots pine forests leading by surface area at 24.2%, followed by native oak forests at 17.3%, poplar forests at 9.7%, Corsican pine forests at 8.5% and birch forests at 7.5% (Govaere & Leyman, 2024).

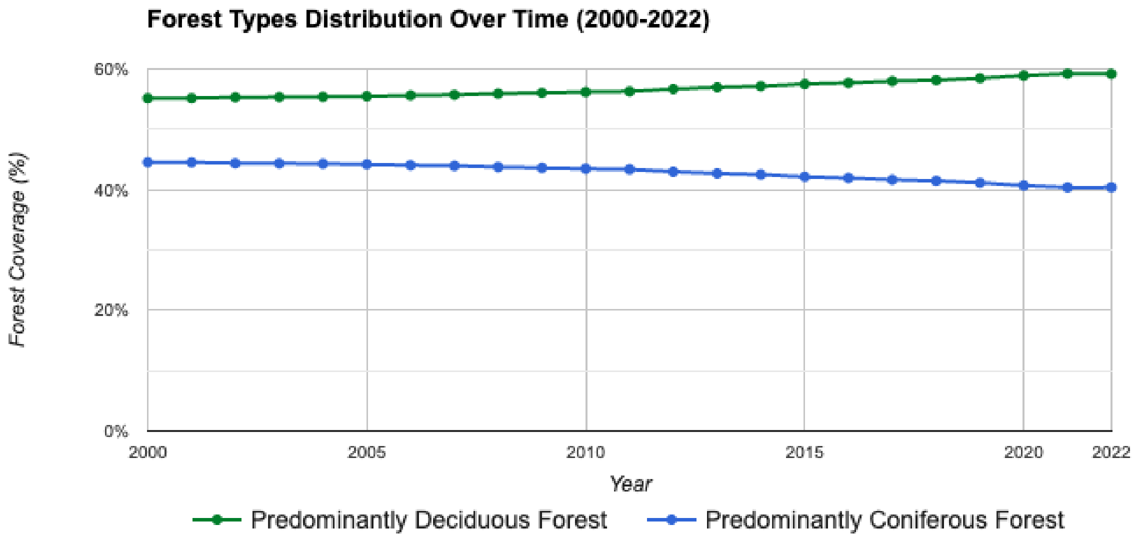


Figure 30: Spatial distribution of forest types in Belgium (2022) (Zhang, et al., 2024).

4.1.3 Forest Tenure

The national split between private and public tenure is almost even, with 53% of private and 47% of public holdings, though regional differences are notable. Wallonia exhibits 51% private ownership, while Flanders shows greater private concentration at 64%. Brussels remains predominantly public at 95% (Filière Bois Wallonie 2024).

Table 43: National split between private and public forest tenure (Fillière Bois Wallonie, 2024).

Region	Private	Public
Belgium	53%	47%
Wallonia	51%	49%
Flanders	64%	36%
Brussels	5%	95%

The private forest landscape reveals extreme tenure fragmentation: in Wallonia, 91% of private forests span less than 5 hectares yet represent only 22% of private forest area, while fewer than 1% exceed 100 hectares but constitute 31% of total private forest surfaces. Flanders presents even more fragmented structure with median patch sizes ranging between 1.5 and 2 hectares and more than 70% of patches smaller than 5 ha (De Keersmaeker, et al., 2015; Verdonck, et al., 2025).

4.1.4 Forest Management Practices

Belgian forests are managed through four primary silvicultural systems, each with distinct applications and impacts on ecosystem services.

4.1.4.1 Even-Aged Systems

Even-Aged Systems remain the most prevalent approach, characterized by clear-cutting, shelterwood methods, and uniform stand structures (du Bus de Warnaffe & Lebrun, 2004; Ligot, et al., 2020). These systems dominate conifer plantations, particularly Norway spruce and Douglas fir stands, as well as some broadleaved forests including beech and oak

(Hilmers, et al., 2020; Aszalós, et al., 2022). In Wallonia, 73% of high forests[8] are even-aged stands with single story structure, with over two-thirds (71%) of even-aged stands being coniferous stands whose area represents 43% of the total productive forest area (Alderweireld, et al., 2016).

4.1.4.2 Uneven-Aged Systems

Uneven-Aged Systems, including selection and group selection methods, are increasingly implemented in mixed and broadleaved forests to promote structural and species diversity (Ligot, et al., 2020; Hilmers, et al., 2020). These approaches maintain continuous forest cover while allowing for selective harvesting and natural regeneration processes. In Wallonia, uneven-aged stands represent 11% of high forests, with two-story stands accounting for an additional 10% (Alderweireld, et al., 2016).

4.1.4.3 Close-to-Nature Systems

Close-to-Nature Systems represent a holistic silvicultural approach that seeks to optimize forest ecosystem functioning by working with natural processes rather than against them. This management strategy prioritizes the maintenance of continuous forest cover, individual tree selection based on quality and natural potential, and the utilization of natural regeneration processes across diverse species compositions. The system emphasizes minimal intervention through frequent but light selective cuts that favor high-quality individuals while preserving the forest's structural complexity and ecological functions. This approach relies heavily on natural processes for tree development, natural pruning, and species succession, creating resilient forest ecosystems that can adapt to changing environmental conditions while maintaining economic productivity through the targeted harvest of premium timber. However, implementing close-to-nature silviculture presents significant operational challenges, requiring highly skilled forest managers capable of making complex, site-specific decisions, adapted harvesting equipment for selective operations, and flexible marketing strategies to handle heterogeneous timber products (Sanchez, 2013). The extent of close-to-nature forestry globally remains difficult to quantify, as adoption is largely voluntary and inconsistently documented across regions. Nevertheless, a comprehensive European analysis by Scherpenhuijzen et al. (2025) (§4.1.4.5) indicates that close-to-nature management encompasses approximately 22.4% of Belgian forests.

4.1.4.4 Set-Aside Systems

Set-Aside Systems represent areas of forest excluded from commercial timber harvesting and reserved for conservation or natural development purposes, operating under strict non-intervention management where natural processes including succession, disturbance, and mortality determine forest structure without human interference. In Belgium, these systems cover more than 10 000 ha, with 8894 ha (1.6%) in Wallonia (Institut wallon de l'évaluation, de la prospective et de la statistique (IWEPS), 2025) 800 ha (0.57%) in Flanders (Landelijk Vlaanderen 2025), and 83 ha (4.15%) in Brussels (the Grippensdelle) (Sonianforest, 2025).

[8] *High forests are forest management system where trees are allowed to reach their full natural height and maturity before harvesting.*

Table 44: Distribution of Even aged, Uneven-Aged, Close-to-Nature and Set-Aside Systems in Belgium and its Regions

Region	Even-Aged Systems	Uneven-Aged Systems	Close-to-Nature Systems	Set-Aside Systems
Belgium	-	-	22.4%	1.4%
Wallonia	73%	11%	23.5%	1.6%
Flanders	-	-	17.6%	0.57%
Brussels	-	-	-	4.15%

4.1.4.5 European-Wide Database

Recent European-wide research by Scherpenhuijzen et al. (2025) provides a valuable comparative context for understanding Belgian forest management practices. The study classifies European forests into five management intensity categories, namely, very intensive forestry, intensive forestry, combined objective forestry, close-to-nature forestry and unmanaged forests. In this study, combined Objective Forestry dominates Belgian forest management. This management class encompasses forests where multiple functions are promoted and no single objective dominates, including protection, recreation, and wood production. At 64.5% of Belgian forests, this management class significantly exceeds the Western European average of 50.02%, which tend to indicate Belgium's strong commitment to multifunctional forestry approaches that balance diverse stakeholder needs and ecosystem services. In the same study, Close-to-Nature Forestry accounts for 22.4% of Belgian forests, defined as systems with limited anthropogenic disturbance, characterized by uneven-aged and mature stand structures where management activities primarily support biodiversity, resilience, and climate adaptation (see §4.1.4.3). This proportion falls below the Western European average of 38.53%, suggesting that while Belgium employs close-to-nature practices, it maintains a stronger emphasis on active management compared to regional trends. Intensive Forestry represents 12.8% of Belgian forests, encompassing forest systems managed for wood production with frequent and/or large-scale felling. This exceeds the Western European average of 7.87%, reflecting Belgium's continued emphasis on timber production within its overall management portfolio. Finally, Very Intensive Forestry and Unmanaged Forest represent minimal portions of Belgian forests at 0.2% and less than 0.1% respectively. This distribution reflects Belgium's developed landscape and sustainable management focus, where neither completely unmanaged areas nor highly intensive short-rotation systems play significant roles in the national forest strategy. In the same study, regional variations in management approaches reflect different priorities and constraints across Belgian territories. Wallonia shows proportions closest to the national average with Combined Objective Forestry at 62.6%, Close-to-Nature Forestry at 23.5%, and Intensive Forestry at 13.9%, indicating a regionally representative approach to forest management. Flanders demonstrates a more intensive multifunctional approach with Combined Objective Forestry dominating at 72.4%, while maintaining Close-to-Nature Forestry at 17.6% and Intensive Forestry at 8.9% (Scherpenhuijzen, et al., 2025).

Table 45: Distribution of Combined Objective Forestry, Close-to-Nature Forestry, Close-to-Nature Forestry, Intensive Forestry, Very Intensive Forestry and Unmanaged Forest in Belgium and its Regions (Scherpenhuijzen, et al., 2025).

Region	Combined Objective Forestry	Close-to-Nature Forestry	Intensive Forestry	Very Intensive Forestry	Unmanaged Forest
Western Europe Average	50.02%	38.53%	7.87%	-	-
Belgium	64.5%	22.4%	12.8%	0.2%	<0.1%
Wallonia	62.6%	23.5%	13.9%	-	-
Flanders	72.4%	17.6%	8.9%	-	-

Finally, it can be noted that current harvesting practices in Wallonia demonstrate a clear shift toward selective management approaches. Among stands with recent harvesting activity, only 9% of high forests were clear-felled while 91% underwent thinning operations. Of these thinning operations, more than 90% used selective methods rather than systematic approaches. This trend toward selective harvesting reflects growing adoption of sustainable forestry practices that maintain forest structure and continuity (Alderweireld, et al., 2016).

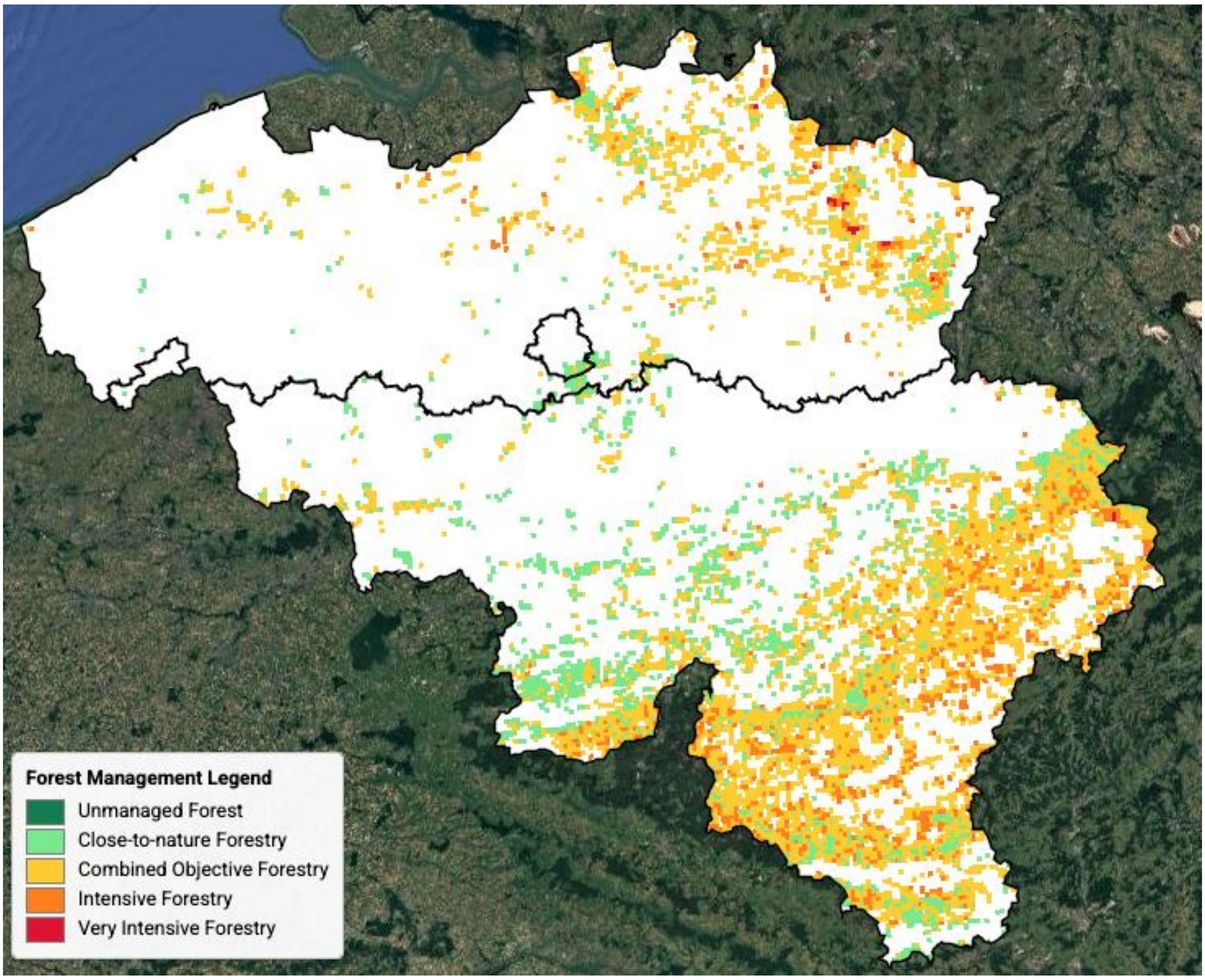


Figure 31: Forest Management Practices Distribution Across Belgium (Scherpenhuijzen et al. 2025).

4.2 Current Carbon Stocks

Belgian forests sequester substantial carbon in both above- and belowground pools. However, methodological inconsistencies produce considerable variation in estimates, reflecting the inherent difficulty of accurately quantifying forest carbon stocks across different assessment frameworks. This analysis focuses on two primary compartments: **biomass organic carbon**, encompassing all aboveground biomass (stems, branches, leaves) and sometimes belowground root systems and deadwood, and litter and **soil organic carbon**, comprising belowground wood fragments, mineral soil carbon, and occasionally root systems.

4.2.1 Biomass Organic Carbon

4.2.1.1 National level

The foundational assessment of biomass organic carbon stocks was conducted by Vande Walle et al. (2005), who quantified total living carbon storage at 223.3 Mt CO_2eq across 693.2 kha of national forest in 2000, yielding a mean density of 370.3 t CO_2eq/ha. This study, drawing on forest inventory data from both Wallonia and Flanders, used literature-based conversion factors for wood density, biomass expansion factors, and carbon content. Lettens et al. (2008) provided a complementary national assessment for the same period, reporting 211.9 Mt CO_2eq of organic carbon across 622 kha (341 t CO_2eq/ha) using a spatially explicit approach.

More recent assessments incorporating remote sensing technologies show substantially higher carbon storage. Miettinen et al. (2025) combined harmonized National Forest Inventory data with Sentinel-2 satellite observations to estimate 254.8 Mt CO_2eq of aboveground carbon in 2020, with a mean density of 305.1 t CO_2eq/ha across 835 kha. However, this larger forest area—significantly exceeding our baseline value of 710 kha — complicates direct comparison with earlier studies. However, since the Miettinen data will serve as our primary spatially explicit dataset, all subsequent spatially explicit datasets will be cropped to the Miettinen data footprint prior to calculation, to ensure consistency. Finally, it is important to note that root biomass is not directly measured in remote sensed data; therefore, this assessment captures above ground carbon only.

The ESA Climate Change Initiative biomass dataset (Santoro & Cartus, 2025) provides an alternative satellite-derived assessment based on multi-temporal L-band observations integrated with spaceborne LiDAR data from GEDI and ICESat-2 missions. Unlike forest-specific assessments, this dataset encompasses all land cover types; therefore, we cropped it to the Miettinen footprint. Using this modified data, the ESA approach yields -202.0 Mt CO_2eq, representing a mean density of -246.0 t CO_2eq/ha.

Table 46: Belgian Forest Biomass Organic Carbon Stock National Assessment.

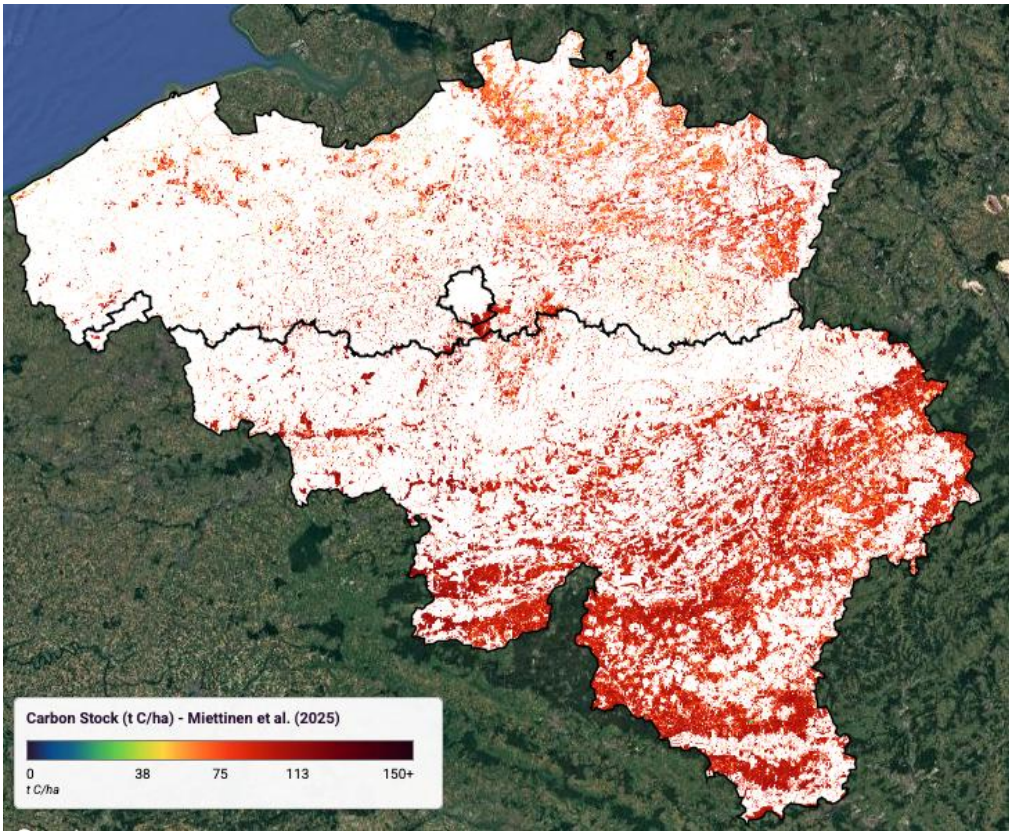
Region	Study	Date	Compartment	Total Storage (Mt CO_2eq)	Mean Density (t CO_2eq/ha)	Area (kha)
Belgium	Vande Walle et al. (2005)	2000	Above ground living trees and living roots	223.3	370.3	693
	Lettens et al. (2008)	2000	Above ground living trees and living roots	211.9	341.0	622
	Miettinen et al. (2025)	2020	Above ground living trees	254.8	305.1	835
	ESA Climate Change Initiative (Santoro and Cartus 2025) cropped	2020	Above ground living trees	202.0	246.0	835

4.2.1.2 Regional level

In productive forests in Wallonia, Latte et al. (2013), estimated the biomass organic carbon stocks (including roots) to 122.9 Mt CO_2eq (264.1 t CO_2eq/ha) across 465 kha in 2003. More recent estimates for Wallonia present a higher value, with an aboveground carbon stock of approximately 178.2 t CO_2eq/ha (Vande Walle, et al., 2005). Current satellite-derived assessments show Wallonia holding the largest share with 188.8 Mt CO_2eq at 316.1 t CO_2eq/ha across 598 kha (Miettinen, et al., 2025). The ESA dataset reveals Wallonia accounts for 159.1 Mt CO_2eq at 268.8 t CO_2eq/ha (Santoro & Cartus, 2025).

In Flanders, Vanhellemont et al. (2024) documented the average aboveground carbon stocks (including dead wood, but not roots) for two management practices: the average managed forests showed 312.0 t CO_2eq/ha, while set-aside (unmanaged) forests showed even higher values, 375.5 t CO_2eq/ha. According to the authors, these set-aside forests accumulate more carbon due to the absence of harvesting losses, their origin from mature old-growth forests with higher initial carbon stocks, and the continuous accumulation of dead wood over time without management intervention. Another site-specific study in East-Flanders (including roots) reveal exceptionally high carbon stocks in mature mixed deciduous stands, with values reaching 451.0 t CO_2eq/ha in oak-beech stands and 419.8 t CO_2eq/ha in ash stands (Vande Walle, et al., 2001).

Recent satellite-derived estimates show Flanders contributing 64.9 Mt CO_2eq at 274.5 t CO_2eq/ha across 235 kha to the national total, while Brussels contributes 0.7 Mt CO_2eq at 334.0 t CO_2eq/ha across 2.2 kha (Miettinen, et al., 2025). The ESA dataset shows Flanders contributes 42.2 Mt CO_2eq at 186.3 t CO_2eq/ha, while Brussels contributes 0.7 Mt CO_2eq at 360.1 t CO_2eq/ha (Santoro & Cartus, 2025).



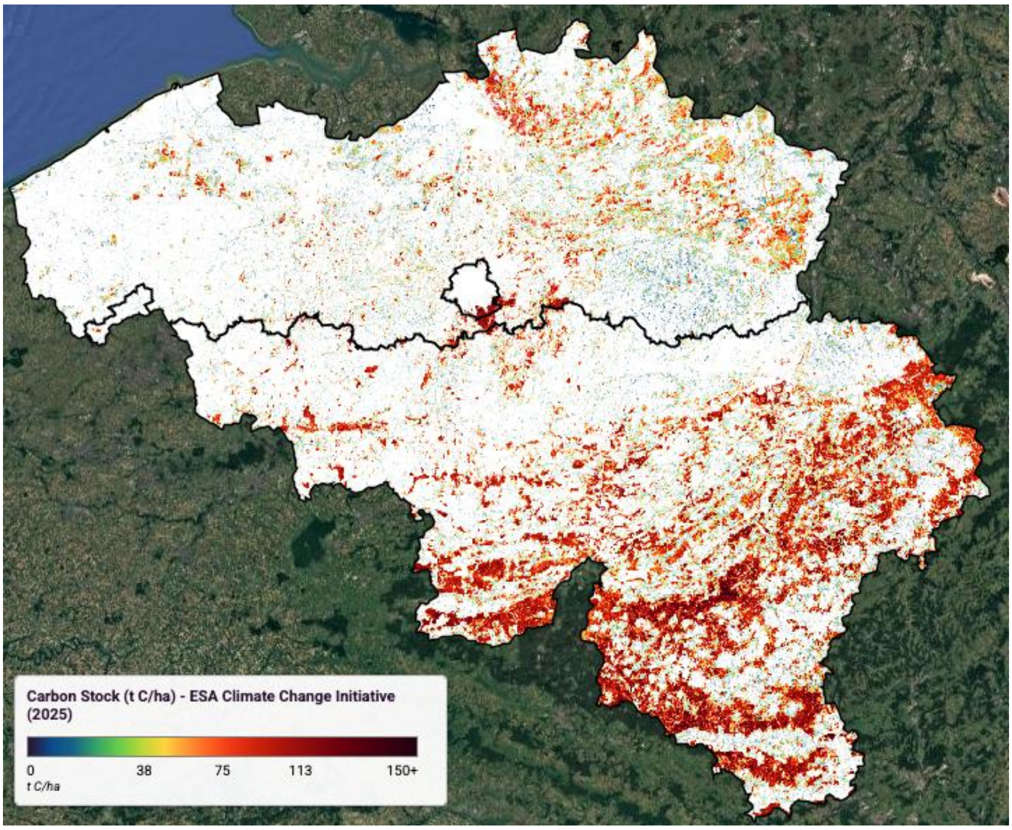


Figure 32: Above Ground Carbon Stock of Forests according to Miettinen et al. (2025) and to ESA Climate Change Initiative (Santoro & Cartus, 2025).

Table 47: Belgian Forest Aboveground Carbon Stock Regional Assessment – Wallonia

Region	Study	Date	Compartment	Total Storage (Mt CO_2eq)	Mean Density (t CO_2eq/ha)	Area (kha)
Wallonia	Vande Walle et al. (2005)	2000	Above ground living trees and living roots	178.2	327.1	544.8
	Latte et al. (2013)	2003	Above ground living trees and living roots (in productive forests)	122.9	264.1	465.3
	Miettinen et al. (2025)	2020	Aboveground biomass	188.8	316.1	598
	ESA Climate Change Initiative (Santoro and Cartus 2025) cropped to Miettinen extent	2020	Aboveground biomass	159.1	268.8	598
Flanders	Vande Walle et al. (2005)	2000	Above ground living trees and living roots	45.1	312.0	146
	Vande Walle et al. (2001)	1997	Above ground living trees (oak-beech stand)	-	565.8	-
			Above ground living trees (ash stand)		541.6	
	Vanhellemont et al. (2024)	2020	Above ground living trees and dead wood (managed forest)	-	312.0	-
			Above ground living trees and dead wood (set-aside forest)		375.5	
	Miettinen et al. (2025)	2020	Aboveground biomass	64.9	274.5	235
	ESA Climate Change Initiative (Santoro and Cartus 2025) cropped to Miettinen extent	2020	Aboveground biomass	42.2	186.3	235
Brussels	Miettinen et al. (2025)	2020	Aboveground biomass	0.7	334.0	2
	ESA Climate Change Initiative (Santoro and Cartus 2025) cropped to Miettinen extent	2020	Aboveground biomass	0.7	360.1	2

The substantial variation across studies reveals considerable challenges in accurately estimating biomass organic carbon density in Belgian forests. National estimates range from 246.0 to 370.3 t CO_2eq/ha, with regional disparities evident in Wallonia (264.1 – 327.1 t CO_2eq/ha) and Flanders (186.3 – 565.8 t CO_2eq/ha). These discrepancies arise from differences from sites specific conditions, temporal coverage, and methodological approaches.

4.2.2 Soil Organic Carbon

Soil organic carbon stocks represent a major component often equal to or exceeding biomass organic carbon stocks in temperate forest ecosystems, with comprehensive assessments revealing substantial storage capacity despite considerable estimate variations.

4.2.2.1 National Level

Data at the national level are very scarce. The only field-based study found is Lettens et al. (2005), which derived soil organic carbon measurements from multiple field datasets to a depth of 30 cm. This study determined an average forest soil organic carbon stock of 333.7 t CO_2eq/ha across 622 kha of forest. Based on these figures, a coarse estimate yields approximately 207 Mt CO_2eq stored in forest soils in Belgium. Fortunately, more recent studies and advance in methodology enabled a comprehensive national assessment. Chartin et al. (2017), conducted this assessment using advanced digital soil mapping approaches calibrated to Soil Map's texture and drainage parameters. This assessment revealed Belgium's total forest soil carbon stock at 320.4 Mt CO_2eq across forest areas, with a mean forest soil carbon density of 368.4 t CO_2eq/ha across 870 kha of Belgian forest for the upper 30 cm.

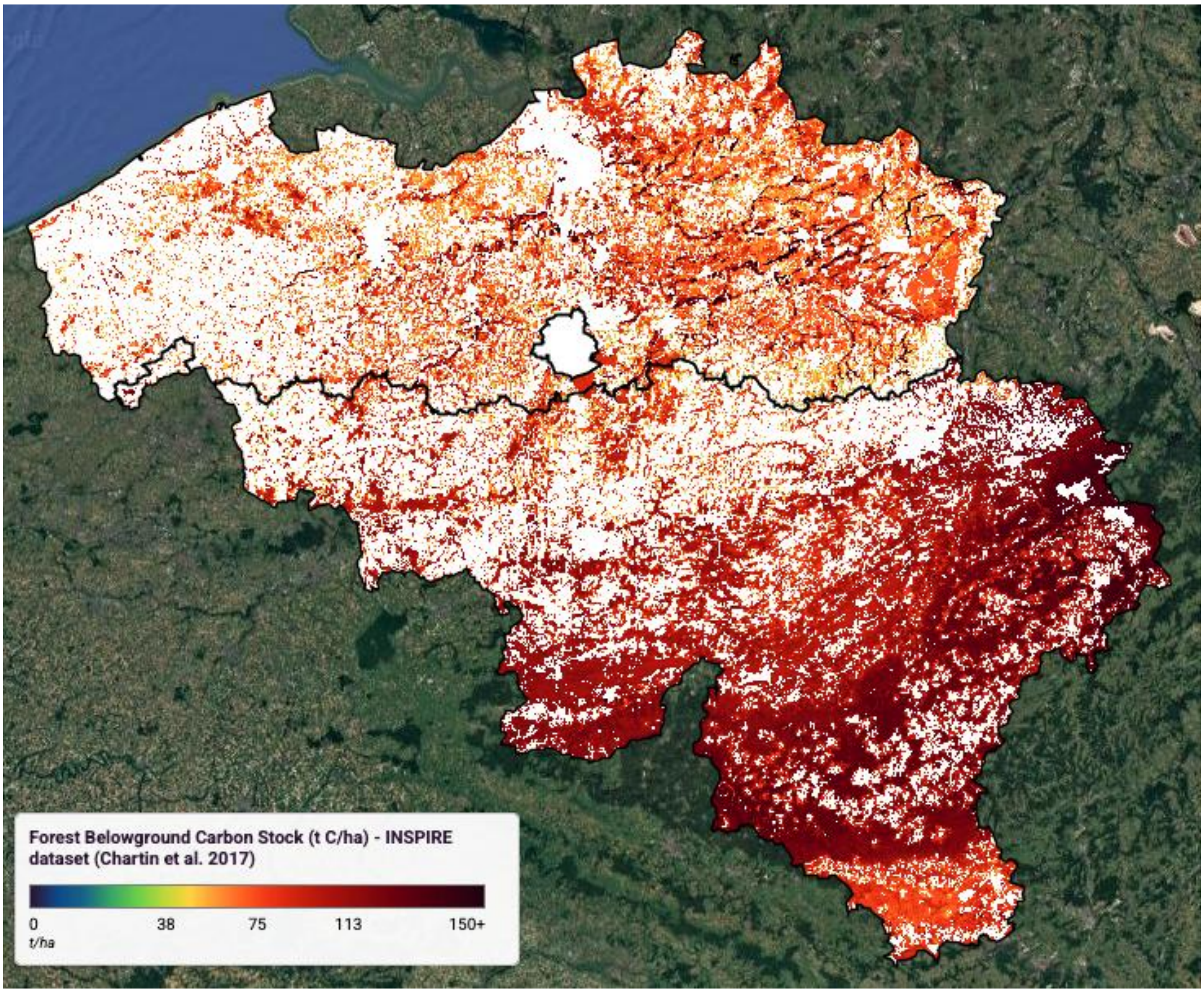


Figure 33: Below Ground Carbon Stock of Forests according to the INSPIRE Dataset (Chartin, et al., 2017) cropped to the Miettinen et al. (2025) extent.

4.2.2.2 Regional Level

Regional-specific assessments for Wallonia developed by Latte et al. (2013) represent the most comprehensive carbon stock estimation procedure by integrating forest inventory data with soil and litter geodatabases, addressing all forest carbon pools including soil organic matter. Their analysis revealed that soil carbon represents the dominant carbon pool, with 150.0 Mt CO_2eq (322.4 t CO_2eq/ha) at 0.2 m depth accounting for 48% of total forest carbon stock. Lettens study (2005) provided another value for carbon soil stock density for Wallonia of 352 t CO_2eq/ha, in the upper 30 cm, while the data from Chartin et al. (2017) provided a total estimate for forest soil carbon of 243.5 Mt CO_2eq (392.4 t CO_2eq/ha) for 621 kha of forest in Wallonia.

In Flanders, Lettens et al. (2005) quantified forest soil carbon at 289.7 t CO_2eq/ha by 2000 in the upper 30 cm of mineral soil. Vande Walle et al. (2001) found soil organic matter stocks of

495 t CO_2eq/ha (for oak-beech stands) and 623.3 t CO_2eq/ha (for ash stands) in the upper 100 cm. Ottoy et al. (2019) used a more comprehensive approach, combining four land-use specific datasets with depth extrapolation functions and digital soil mapping techniques to estimate the total forest belowground organic carbon in Flanders at 99.0 Mt CO_2eq (645.0 t CO_2eq/ha) in the upper 100 cm of 154 kha of Flanders forest. The data from Chartin et al. (2017) provided a total estimate for forest soil carbon of 76.9 Mt CO_2eq (308.7 t CO_2eq/ha) for 263.5 kha of forest in Flanders.
Finally, the Flemish soil carbon monitoring network (Cmon) sampled the soil of 128 forest plots and estimated the average belowground carbon stock in the upper 30 cm forest soil at 321.6 t CO_2eq/ha (Oorts et al., 2024).

Table 48: Belgian Forest Belowground Carbon Stock Assessment

Region	Year	Depth (cm)	Study	Total storage (Mt CO_2eq)	Mean Density (t CO_2eq/ha)	Forest Area (kha)
Belgium	2004-2014	0-30	Chartin et al. (2017)	320.4	368.4	870
	2000	0-30	Lettens et al. (2005)	± 207	333.7	622
Wallonia	2005	0-20	Latte et al. (2013)	150	322.4	465
	2000	0-30	Lettens et al. (2005)	-	352	-
	2017	0-30	Chartin et al. (2017)	243.5	392.4	621
Flanders	2017	0-30	Chartin et al. (2017)	76.9	308.7	263
	2000	0-30	Lettens et al. (2005)	-	289.7	-
	1997-2003	0-100	Ottoy et al. (2017)	99.0	645.0	154
	2001	0-100	Vande Walle et al. (2001)	-	495.0 (oak-beech) 623.3 (Ash)	-
	2024	0-30	Oorts et al. (2024)	-	321.6	-
Brussels	2017	0-30	Chartin et al. (2017)	0.02	287.3	0.076

The assessment of Belgian forest belowground soil organic carbon density shows that Belgian soils contain between 333.7 – 368.4 t CO_2eq/ha for the upper 30 cm of soil. Wallonia contains 322.4 to 392.4 t CO_2eq/ha, Flanders 308.7 to 289.7 t CO_2eq/ha, and Brussels 287.3 t CO_2eq/ha, all for the upper 30 cm depth, revealing considerable variation depending on sampling protocols, measurement methods, soil depth coverage and temporal representation.

4.3 Current Carbon Sequestration Rates

4.3.1 National Level

Belgian forests demonstrate substantial carbon sequestration capacity across the national territory. Historical assessment by Lettens et al. (2008) quantified carbon accumulation in Belgian forests between 1984-2000, revealing a sequestration of -1.31 Mt CO_2eq/yr across 508 kha, yielding an average annual rate per hectare of -2.57 t CO_2eq/ha/yr. In the same study, forest type-specific sequestration rates in Wallonia show substantial variations, with coniferous forests demonstrating the highest rates at -5.87 t CO_2eq/ha/yr, mixed forests at -1.83 t CO_2eq/ha/yr, and broadleaf forests at -1.47 t CO_2eq/ha/yr.
Analysis using the Global Forest Watch Carbon Flux Model cropped to the Miettinen et al. (2025), extent revealed a total net carbon sequestration of -2.42 Mt CO_2eq/yr over the 24-year analysis period (2001-2024) across 835 kha of Belgian forest. The mean net carbon

absorption rate can therefore be estimated as -3.38 t CO_2eq/ha/yr, with more than 75 % of the total forest area actively functioning as carbon sinks (Harris, et al., 2021).
Finally, according to the Belgian Interregional Environment Agency, 2023 data indicates a mean carbon sequestration rate of -2.51 t CO_2eq/ha/yr across Belgian forests (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

4.3.2 Regional Level

Wallonia's 598 kha forest area contributes the largest absolute carbon removals among Belgian regions at -1.04 Mt CO_2eq/yr, averaging -1.95 t CO_2eq/ha/yr across 598 kha. However, Flanders demonstrates a higher per hectare sequestration rates, achieving -1.36 Mt CO_2eq/yr in net removals across just 235 kha—equivalent to -7.41 t CO_2eq/ha/yr. Brussels presents the highest per-hectare sequestration, with a net flux of -0.02 Mt CO_2eq/yr over 2.17 kha, equivalent to -9.84 t CO_2eq/ha/yr (Harris, et al., 2021). The exceptionally high sequestration rates in Flanders and Brussels likely reflect the predominance of young, actively growing forest stands in the region.
These values are slightly higher than the estimates by Vanhellemont et al. (2024), who reported in Flanders -4.77 t CO_2eq/ha/yr for managed stands and -6.60 t CO_2eq/ha/yr for set-aside stands.

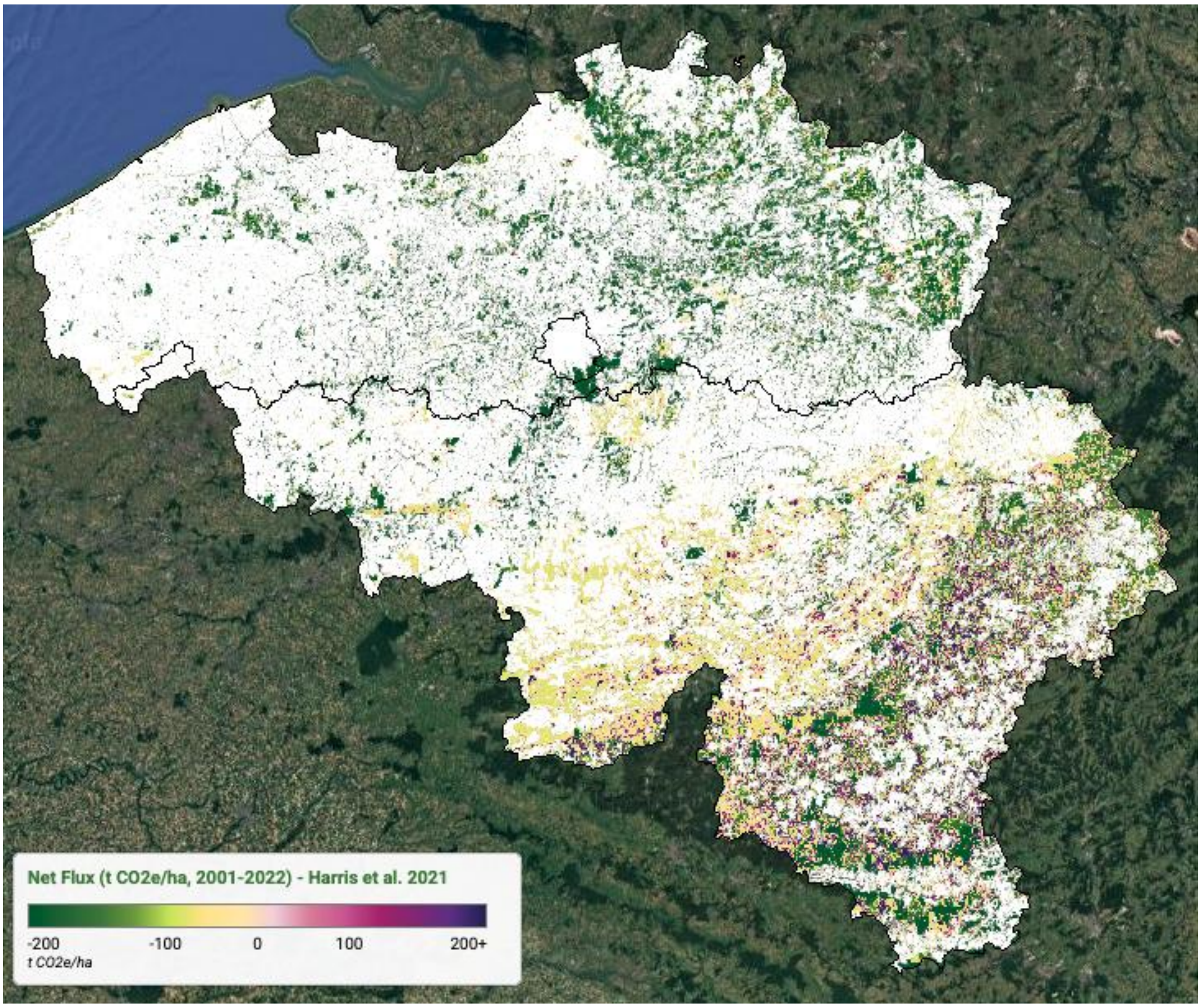


Figure 34: Net Carbon Flux in Belgium (2001-2022) (Harris, et al., 2021), cropped to the Miettinen et al. (2025) forest extent.

4.3.3 Trends in carbon sequestration

Forest carbon sequestration rates in Belgium show contradictory patterns depending on the data source examined. The Belgian Interregional Environment Agency (CELINE-IRCEL) inventory indicates declining net carbon sequestration rates for total forest land at -0.65% per year between 2000 and 2023, disaggregated into -1.51% per year for forest land remaining forest land and -0.68% for land converted to forest land (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

Conversely, other studies suggest an upward trend. Horemans et al. (2020) reported increased forest sequestration rates in Campine forests during the last decade. Storms et al. (2022) has demonstrated that specific species in Flanders and the Netherlands has seen a 13% increase in productive between 1987 and 2016 compared to the growth during the 1961–1990 period. Similarly, comparing Global Forest Watch analysis (2001-2024: -3.38 t CO_2eq/ha/yr) with Lettens et al. (2008) (1984-2000: -2.57 t CO_2eq/ha/yr) suggests a 2.47% annual increase in CO_2 absorption. However, this comparison should be interpreted with caution, as methodological variations in carbon flux quantification between these studies could substantially explain the observed differences (Storms, et al., 2022).

Given the conflicting evidence on Belgium's forest carbon sequestration rates, we adopt a pragmatic approach by acknowledging the plausible range suggested by the literature. While the CELINE-IRCEL data indicates declining sequestration rates, the weight of evidence from process-based studies and temporal comparisons points toward stable or slightly increasing carbon uptake. Recognizing that methodological differences in carbon quantification substantially limit direct comparisons across studies, we conservatively assume Belgium's forest carbon sequestration rate will remain stable within the range of -2.5 to -3.38 t CO_2eq/ha/yr.

Table 49: Belgian Forest Carbon sequestration Assessments.

Region	Period	Component	Study	Sequestration Rate (t CO_2eq/ha/yr)
Belgium	2001-2024	Aboveground biomass	Harris et al. (2021)	-3.38
	2001-2022	Aboveground and belowground biomass	Lettens et al. (2008)	-2.57
	2023	Aboveground biomass	Belgian Interregional Environment Agency [CELINE-IRCEL] (2025).	-2.5
Wallonia	2001-2024	Aboveground biomass	Harris et al. (2021)	-1.95
Flanders	2001-2024	Aboveground biomass	Harris et al. (2021)	-7.41
	10 and 15 years during 1997-2017	Aboveground biomass - Managed	Vanhellemont et al. (2024)	-4.77 (Managed) -6.60 (Set-aside)
Brussels	2001-2024	Aboveground biomass	Harris et al. (2021)	-9.84

Projecting carbon sequestration in Belgian forests over the next 25 years and beyond presents significant challenges. Estimates vary considerably (as discussed in the previous section), and carbon absorption depends on multiple interacting factors including climate, microclimate, soil composition, species selection, silvicultural practices, and forest management systems. These factors create complex feedback loops that make accurate predictions difficult. Comprehensive modeling approaches—such as those developed by Gregor et al. (2024) in Germany—would be necessary to account for these interactions, but such detailed analyses have not yet been conducted for Belgian forests.

In this report, we provide a conservative estimate of carbon sequestration based on current trends and potential landcover change scenarios. In the following sections, we present both the quantitative projections of afforestation / deforestation and a qualitative analysis of the environmental, biological and management variables that could enhance or diminish carbon sequestration rates in Belgian forests over this period.
Our analysis examines how deforestation and afforestation—the two primary mechanisms of carbon sequestration change through land cover conversion—reshape carbon storage. We model these processes according to the assumptions outlined below to maintain methodological rigor and transparency.

4.3.4 Calculations Methodology

4.3.4.1 Basic assumptions

In this study, deforestation is defined as the clear-cutting of a specified area, resulting in complete removal of all biomass and organic carbon stock and the cessation of carbon sequestration. All biomass organic carbon removed during this process is treated as emitted in our calculations.
Afforestation and deforestation activities are distributed uniformly across the 25-year projection period to reflect realistic management timelines and policy implementation schedules. Calculations are performed at the regional scale and then aggregated to the national scale. When land cover change is not specified at the regional level, the change is distributed proportionally across regions based on their forest extent.
Our analysis focuses exclusively on above-ground carbon storage. Although afforestation can theoretically achieve significant carbon sequestration, soil carbon accumulation extends beyond our 25-year timeframe. During the initial 0–10 years following land use conversion, soil carbon typically remains unchanged or declines slightly due to soil disturbance, regardless of previous land use. Statistically significant soil carbon increases require ≥30 years on agricultural lands and 15 years on industrial or barren lands (Hou et al. 2020; Nave et al. 2013). Therefore, soil carbon dynamics are excluded from this analysis.

4.3.4.2 Juvenile forest absorption rate

Afforestation is modelled as the establishment of juvenile saplings. Recognizing that young forests sequester carbon at lower rates than mature forests, we applied absorption rates specific to stands aged 0–20 years, derived from Bernal et al. (2018) (see Table 50). After this 20-year establishment period, sequestration rates are assumed to approach the current levels observed in Belgian forests.

Table 50: Absorption rates for juvenile plots for Broadleaves Conifers (except pines), and pines (Bernal, et al., 2018).

Forest type	Minimum absorption rate ($t\ CO_2eq/ha/yr$)	Maximum absorption rate ($t\ CO_2eq/ha/yr$)
Broadleaf - Temperate, all	-10.40	-13.20
Conifer (except pines) - Temperate, all	-3.50	-5.50
Pines - Temperate, humid	-16.60	-25.60

To calculate regional absorption rates, we applied a weighted mean of juvenile forest sequestration rates for each forest type, using the proportion of that forest type within each region as weights, as follows:

$$AbsJ_{region}^{min} = \frac{\sum_{i=1}^{n} w_{i,region} \times AbsJ_i^{min}}{w_{i,region}}$$

$$AbsJ_{region}^{max} = \frac{\sum_{i=1}^{n} w_{i,region} \times AbsJ_i^{max}}{w_i, region}$$

where $\text{AbsJ}_{\text{region}}^{\min/\max}$ is the minimum/maximum absorption rate from juvenile forest plots in the specified region, $w_{i,\text{region}}$ is the proportion of forest type i within the region, and $\text{AbsJ}_i^{\min/\max}$ is the minimum/maximum absorption rate from juvenile plots of forest type i.

Table 51: Regional proportion of total forest and forest type forests in Belgium. Adapted from NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024), Filière bois Wallonie 2024 (Fillière Bois Wallonie, 2024) and Govaere and Leyman 2024 (Govaere & Leyman, 2024).

Region	% of Belgian forest	% Broadleaf	% Conifer (except pine)	% Pine
Wallonia	75.40%	56.20%	39.60%	1.60%
Flanders	24.30%	64.00%	3.30%	32.70%
Brussels	0.30%	98.00%	2.00%	0.00%

Regional minimum and maximum absorption rates for juvenile forest calculated using data from Table 50 and Table 51 are presented in Table 52.

Table 52: Regional minimum and maximum absorption rates for juvenile forests.

Region	Minimum absorption rate (t CO_2eq/ha/yr)	Maximum absorption rate (t CO_2eq/ha/yr)
Wallonia	-7.50	-10.01
Flanders	-12.20	-17.00
Brussels	-10.26	-13.05
Belgium	-8.75	-11.81

4.3.4.3 Annual Afforestation and Deforestation Rates

Given that both afforestation and deforestation activities are uniformly distributed over the 25-year projection period, if A represents the total afforestation target for the scenario in the region, D represents the total deforestation target, and l equals 25 years, then the annual expected afforestation (A_{yr}) and deforestation (D_{yr}) are calculated as:

$$A_{yr} = \frac{A}{l}$$

$$D_{yr} = \frac{D}{l}$$

4.3.4.4 Forest Area Dynamics

For each year t, the area of juvenile forest (J_{yr}) in the region is calculated as the cumulative sum of annual expected afforestation (A_{yr}) over the preceding 20 years:

$$J_{yr} = \sum_{i=t-19}^{t} A_{yr}$$

The area of mature forest (M_{yr}) in the region comprises all afforestation older than 20 years:

$$M_{yr} = \sum_{i=0}^{t-20} A_{yr}$$

4.3.4.5 Carbon Emissions

The minimum/maximum annual carbon emission from deforestation for the region ($E_{yr}^{min/max}$) is calculated as the annual expected deforestation (D_{yr}) multiplied by the minimum/maximum average above-ground biomass carbon stock for the region ($BOC_{region}^{min/max}$):

$$E_{yr}^{min} = D_{yr} \times BOC_{region}^{min}$$

$$E_{yr}^{max} = D_{yr} \times BOC_{region}^{max}$$

minimum/maximum average above-ground biomass carbon stocks were presented in the previous section and are summarized in Table 53.

Table 53: Minimum and Maximum Average Above-Ground Biomass Carbon Stocks

Region	Minimum above-ground biomass carbon stock ($t\ CO_2eq/ha$)	Maximum above-ground biomass carbon stock ($t\ CO_2eq/ha$)
Wallonia	264.1	327.1
Flanders	186.3	565.8
Brussels	334.0	360.1
Belgium	246.0	370.3

4.3.4.6 Carbon Absorption

The minimum/maximum total carbon absorption ($AbsT_{yr}^{min/max}$) for the region is calculated as:

$$AbsT_{yr}^{min} = AbsJ_{region}^{min} \times J_{yr} + AbsM_{region}^{min} \times (F_{base} + M_{yr} - D_{yr}) - E_{yr}^{\boldsymbol{max}} \times D_{yr}$$

$$AbsT_{yr}^{max} = AbsJ_{region}^{max} \times J_{yr} + AbsM_{region}^{max} \times (F_{base} + M_{yr} - D_{yr}) - E_{yr}^{\boldsymbol{min}} \times D_{yr}$$

where J_{yr} is the area of juvenile forest in the region, $AbsJ_{region}^{max}$ is the minimum absorption rate for juvenile forest, F_{base} is the baseline forest cover in 2022 from the CELINE-IRCEL NIR-database, M_{yr} is the area of mature forest, D_{yr} is the annual expected deforestation, and $E_{yr}^{min/max}$ is the minimum/maximum emission rate for mature forest deforestation. Note that for **minimum** total carbon absorption, the **maximum** emission rate for mature forest deforestation is used (and vice versa).

4.3.5 Results

These calculations are applied systematically to each scenario. Detailed yearly calculations for each scenario are presented in Annex 5.

4.3.5.1 Reference scenario

The reference scenario reflects baseline land-use trends in Belgium, characterized by annual equilibrium between deforestation and afforestation:

- Deforestation: 23 kha converted to grassland (10 kha), cropland (3 kha) and settlement (10 kha)
- Afforestation: 23 kha converted from grassland (20 kha) and cropland (3 kha)

Over the 25-year projection period, this scenario maintains approximate forest cover equilibrium with annual rates of 920 ha deforestation and 920 ha afforestation, both distributed in each region according to their forest proportion.
The reference scenario yields total annual carbon absorption ranging from -1.65 to -2.21 Mt CO_2eq/yr throughout the 25-year projection period. Following the cessation of land-use conversion activities after 2050, carbon absorption peaks in 2051 at -1.99 to -2.48 Mt CO_2eq/yr, driven by large quantities of juvenile forests transitioning to higher mature absorption rates while deforestation ceases simultaneously.
Absorption subsequently decreases gradually as newly established forests mature and transition to stable carbon sequestration patterns. By 2070—20 years after the final afforestation—the system stabilizes to a range of -1.88 to -2.34 Mt CO_2eq/yr, representing the long-term carbon sequestration potential under reference scenario conditions.

4.3.5.2 Current policy scenario

The current policy scenario reflects the implementation of current policies established by the regional governments. It plans for 23 000 hectares (kha) of afforestation nationally, with an additional 10 kha specifically in Flanders, and 15 kha of deforestation nationally between 2026 and 2050.
This translates to the following annual rates by region:

- Wallonia: 694 ha of afforestation and 452 ha of deforestation per year
- Flanders: 624 ha of afforestation and 156 ha of deforestation per year
- Brussels: 3 ha of afforestation and 2 ha of deforestation per year

Following the calculations presented above, this scenario yields total annual carbon absorption ranging from -1.98 to -2.46 Mt CO_2eq/yr. Following the cessation of land-use conversion activities after 2050, carbon absorption peaks in 2051 at -2.11 to -2.66 Mt CO_2eq/yr, driven by large quantities of juvenile forests transitioning to higher mature absorption rates while deforestation ceases simultaneously.
Absorption subsequently decreases gradually as newly established forests mature and transition to stable carbon sequestration patterns. By 2070—20 years after the final afforestation—the system stabilizes to a range of -1.95 to -2.44 Mt CO_2eq/yr, representing the long-term carbon sequestration potential under current policy scenario conditions.

4.3.5.3 Major change scenario

The major change scenario represents the most ambitious pathway, targeting 80 kha total afforestation across Belgium with no deforestation. This corresponds to 3.2 kha of afforestation annually distributed in each region according to their forest proportions.
Following the calculations presented above, this scenario yields total annual carbon absorption ranging from -2.23 to -2.81 Mt CO_2eq/yr. Following the cessation of land-use conversion activities after 2050, carbon absorption peaks in 2050 at -2.48 to -3.14 Mt CO_2eq/yr, driven by large quantities of juvenile forests transitioning to higher mature absorption rates.
Absorption subsequently decreases gradually as newly established forests mature and transition to stable carbon sequestration patterns. By 2070—20 years after the final afforestation—the system stabilizes to a range of -2.10 to -2.60 Mt CO_2eq/yr, representing the long-term carbon sequestration potential under major change scenario conditions.

Table 54: Forest Carbon Sequestration Metrics for Each Scenario.

Scenario	Period	Carbon Sequestration (Mt CO_2eq/yr)
Current Emissions	Current	-1.59 to -2.12
Reference Scenario	Years 2026-2050	-1.65 to -2.21
	Peak (2051)	-1.99 to -2.48
	Long-term (2070+)	-1.88 to -2.34
Current policy Scenario	Years 2026-2050	-1.98 to -2.46
	Peak (2051)	-2.11 to -2.66
	Long-term (2070+)	-1.95 to -2.44
Major Change Scenario	Years 2026-2050	-2.23 to -2.81
	Peak (2050)	-2.48 to -3.14
	Long-term (2070+)	-2.10 to -2.60

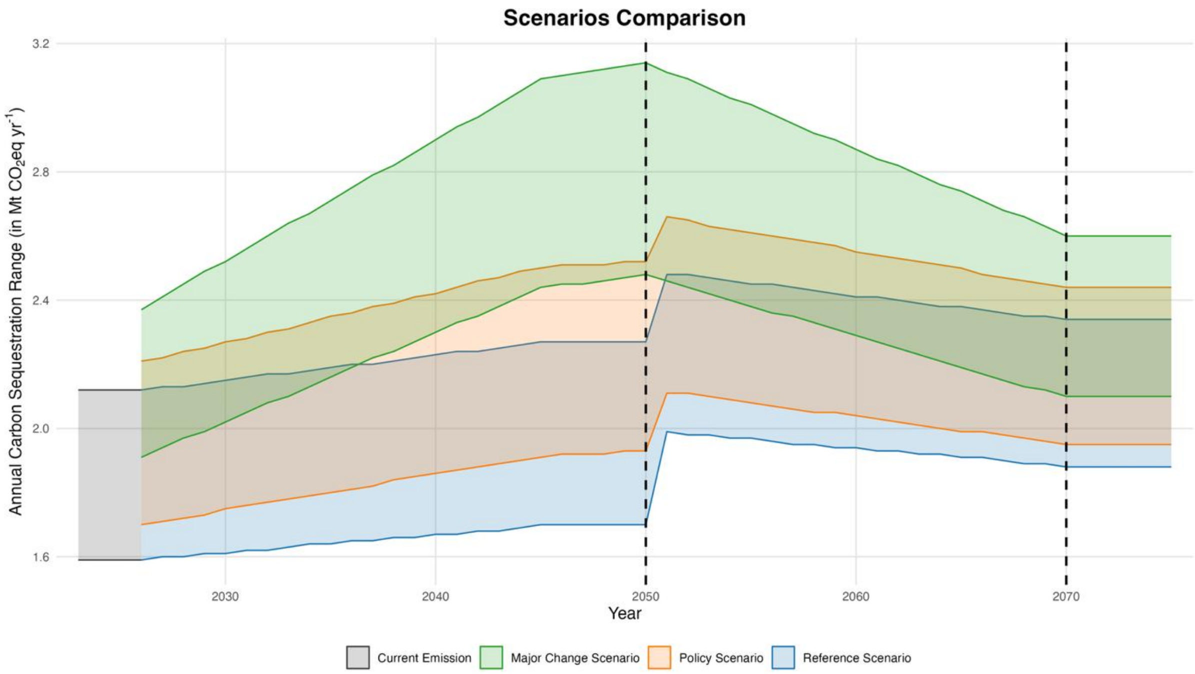


Figure 35: Carbon Sequestration Range for Each Scenario. Here the current emission is assumed to be equal to the emission during the first year of reference scenario.

4.4 Other Factors Influencing Carbon Sequestration and Storage

Forest carbon sequestration operates within a complex framework of interacting environmental, biological, and management variables that extend far beyond simple relationships with land cover changes and forest age. While the quantitative effects of these factors remain uncertain or difficult to integrate into robust estimates at the national scale, a qualitative assessment can reveal some directional trends that could improve carbon sequestration dynamics.

4.4.1 Soil Properties and Site Conditions

Forest carbon sequestration is fundamentally constrained by site conditions, with soil quality serving as a primary driver of above- and below-ground carbon storage. Research on Flemish forests demonstrates this principle: set-aside forests on fertile soils (silt and sandy silt) achieve above-ground carbon sequestration rates of -8.1 to -8.8 t CO_2eq/ha/yr, compared to only -5.1–-6.6 t CO_2eq/ha/yr on less productive wet and sandy sites— 40–70% productivity differential (Vanhellemont, et al., 2024).

Soil texture and nutrient availability are primary controls. Clay and fine silt content emerge as the most significant predictors of forest productivity in Wallonia, alongside groundwater depth. Nutrient response efficiency is species-dependent: beech shows optimal phosphorus and potassium response in mixed-species stands, while functional tree traits and forest standing biomass explain approximately 50% of local soil carbon variability, with effects strongest on acidic, poor soils (Schmidt, et al., 2015; Augusto & Boča, 2022; de Wergifosse, et al., 2020).

Soil water-holding capacity directly constrains forest productivity by determining plant-available water between field capacity and wilting point. Loamy and silt-loam soils represent productivity optima because they maintain accessible pore space and intermediate water retention, compared to sandy soils (10–18% water by volume at field capacity) that rapidly desiccate or clay soils (38–42% retention) where water is bound too tightly for plant extraction (Saxton & Rawls, 2006). Forest plots with higher structural complexity—larger average tree size and greater species richness—demonstrate 4–64% higher total water-holding capacity across soils, litter, and canopy combined (Yang, et al., 2023), indicating that stand structure directly influences the hydrological foundation for carbon flux.

Soil pH and clay mineralogy jointly determine nutrient availability and carbon stabilization through organomineral complexation. Acidic forest soils (pH < 5) restrict phosphorus bioavailability through increased sorption on iron and aluminum oxides (Johan, et al., 2021), creating phosphorus-limited conditions despite moderate total phosphorus content. The type and abundance of clay minerals control mineral-associated organic matter persistence, with organomineral complexes representing the strongest carbon stabilization mechanism (Barré, et al., 2014). Soils rich in iron oxides and clay minerals with high cation exchange capacities can stabilize carbon for centuries to millennia through strong chemical bonding (Lützow, et al., 2006; Lehmann & Kleber, 2015), whereas kaolinite-dominated soils offer substantially weaker protection due to fewer reactive sites.

Table 55: Soil Factors Influencing Carbon Sequestration.

Factor	Description	Impact	Quantitative Effect	Source
Soil Fertility & Texture	Productive soils with optimal clay and silt content provide better water availability and nutrient cycling for carbon accumulation.	+	-8.1 – -8.8 t CO_2eq/ha/yr (fertile) vs -5.1–6.6 (poor); 40–70% differential; loamy/silt-loam optimal	Vanhellemont et al. 2024; Saxton & Rawls 2006; Schmidt et al. 2015
Soil Water-Holding Capacity & Structure	Water accessibility between field capacity and wilting point constrains forest productivity; structurally complex stands hold more water.	+	4–64% higher total water capacity in structurally complex stands	Yang et al. 2023; Saxton & Rawls 2006
Soil pH & Clay Mineralogy	Acidic soils restrict nutrient availability while clay minerals with high cation exchange capacity stabilize carbon for centuries to millennia.	+/−	Acidic soils (pH < 5) reduce P availability; mineral-associated carbon persists longest in reactive clay soils	Johan et al. 2021; Lützow et al. 2006; Lehmann & Kleber 2015
Stand Biomass & Functional Traits	Local vegetation structure and tree characteristics explain half of soil carbon variability, with stronger effects on poor soils.	+	~50% of soil carbon variability explained; strongest on acidic soils	Schmidt et al. 2015; Augusto & Boča 2022

4.4.2 Species Composition

Forest species composition exerts primary control on above-ground carbon sequestration through multiple mechanisms including differential growth rates, wood density variation, and complementary resource use in mixed stands. Species composition fundamentally determines how carbon is distributed across vegetation, litter, and soil compartments, with profound implications for both sequestration magnitude and persistence.

Meta-analyses across Europe demonstrate substantial benefits from mixing species, particularly when broadleaf trees are incorporated into coniferous systems. Beech stands mixed with conifers (spruce, Douglas fir, and pine) showed 60% higher organic carbon stocks in the forest floor compared to beech monoculture, with mixed beech-pine stands achieving -1.32 t CO_2eq/ha/yr additional sequestration rates (Rehschuh, et al., 2021). These benefits arise not from simple additive effects, but from complementary resource use where species with different rooting depths, phenological timing, and light acquisition strategies utilize available resources more completely. In a mixed deciduous forest in Germany, medium-sized trees (30–60 cm stem diameter) accounted for 66% of total productivity, demonstrating that stand structure mediated by species interactions profoundly influences carbon flux dynamics (Holtmann, et al., 2021).

Research on Norway spruce and European beech mixed forests showed that combined effects of litterfall and root turnover significantly increase topsoil carbon stocks in mixed stands through complementarity effects (Legout, et al., 2016). In contrast, climate warming may drive replacement of beech forests by thermophilic oak forests in drought-affected regions, potentially reducing ecosystem carbon storage in both aboveground biomass and soil (Špulák, et al., 2023).

The mycorrhizal associations characterizing different tree communities fundamentally mediate forest carbon sequestration. Ectomycorrhizal species (such as pine, dominant on sandy soils in Flanders) and arbuscular mycorrhizal species (associated with nutrient-rich soils supporting broadleaf forests) partition soil carbon differently. Ectomycorrhizal forests store more carbon in the particulate organic matter fraction, which is more vulnerable to disturbance but has lower nitrogen demand and can potentially accumulate indefinitely, whereas arbuscular mycorrhizal forests accumulate carbon in mineral-associated forms that are longer-lasting but susceptible to saturation (Jiang, et al., 2025).

Mineral soil carbon storage differs markedly between species, with broadleaf stands generally retaining more soil carbon at deeper depths compared to pine stands (Osei, et al., 2021). The differences in species-specific soil carbon dynamics, particularly at different soil depths, represent an often-overlooked component of management effects on total ecosystem carbon storage.

Table 56: Species Composition Factors Influencing Carbon Sequestration.

Factor	Description	Impact	Quantitative Effect	Source
Mixed-Species & Broadleaf Systems	Mixing species (especially broadleaf with conifers) increases complementary resource use and substantially boosts organic carbon in forest floor and soil.	+	60% higher forest floor carbon; -1.32 t CO_2eq/ha/yr additional sequestration (beech-pine); 66% productivity from medium-sized trees	Rehschuh et al. 2021; Holtmann et al. 2021; Legout et al. 2016
Mycorrhizal Associations & Soil Carbon Depth	Different tree species form distinct mycorrhizal networks that partition soil carbon differently (broadleaf stores deeper, longer-lasting carbon).	Unclear	Broadleaf retains more soil carbon at deeper depths; ectomycorrhizal stores vulnerable particulate organic matter	Jiang et al. 2025; Osei et al. 2021
Climate-Driven Species Shifts	Warming may replace beech with thermophilic oaks in drought	–	Potential reduction in ecosystem carbon storage (aboveground & soil)	Špulák et al. 2023

	regions, potentially reducing total ecosystem carbon storage.			

4.4.3 Forest Structure and Management Intensity

The vertical and horizontal distribution of trees within forest stands—forest structure—fundamentally influences carbon sequestration rates and storage stability. The structural organization of forests determines how efficiently trees utilize growing space and light resources, directly affecting biomass accumulation and carbon uptake capacity. Forest structure also influences the persistence of carbon stocks through time, with complex, multi-layered stands generally showing greater resilience to disturbances and more stable long-term carbon storage than simplified structures (Vandekerkhove, et al., 2016).

Management intensity, which alters stand composition through harvesting operations and silvicultural interventions, emerges as an important variable affecting sequestration dynamics. Research on temperate forest carbon dynamics reveals that intensive biomass harvesting significantly reduces carbon stocks compared to lower-intensity management. Intensive harvests induce large soil organic carbon losses in comparison with untouched forests, with losses occurring mainly in the forest floor (−37%) and in deep soil layers (−7%) (Achat, et al., 2015). At the global scale, increasing temperate-zone tree harvests over three decades (+17%) caused loss of stocks (Pan, et al., 2024). The implementation of management strategies based on intensive harvests would cause a loss of organic carbon in forest soils, ranging between 521 and 1822 t CO_2eq in Europe, depending on the scenario of management conversion (Achat, et al., 2015).

Comparative analysis of management intensities reveals dramatic performance differences in carbon sequestration across temperate European forests. In Flanders, set-aside forests in managed landscapes generate -6.6 t CO_2eq/ha/yr, substantially outperforming actively managed stands at -4.8 t CO_2eq/ha/yr, representing a 38% advantage (Vanhellemont, et al., 2024). These findings underscore the carbon cost of intensive harvesting operations.

Shorter harvest rotation cycles present a complex tradeoff for carbon sequestration at both ecosystem and landscape scales. While younger, regenerating forests exhibit accelerated growth rates and higher annual sequestration rates during establishment, cumulative carbon storage over longer time horizons depends critically on-site productivity and the management approach employed (Carlisle, et al., 2023). On highly productive sites in temperate regions, optimal carbon accumulation occurs with rotation periods of 60 years paired with low-intensity thinning interventions, whereas less productive sites maximize total carbon stocks under 80–120 year rotations with strategic thinning cycles (Carlisle, et al., 2023). Increasing harvest frequency to shorter rotations—particularly when coupled with frequent soil disturbance—can offset gains from youthful tree growth through accelerated heterotrophic respiration from harvested debris and reduced soil organic carbon accumulation, resulting in net losses of total ecosystem carbon relative to longer, lower-intensity management cycles (Moktan, et al., 2025). European data demonstrate this dynamic: current elevated harvest intensities have contributed to declining forest carbon removals across the EU over the past decade, despite rising global harvesting volumes (European Environment Agency, 2025).

Short-rotation forestry systems, when established on appropriate marginal soils rather than converted from existing forest, show potential for supplementary carbon sequestration through complementary biomass production and soil organic carbon accumulation. Short-rotation forestry of poplar and willow species in Flanders (Belgium) demonstrates energy production potential while contributing to reduced fossil fuel emissions through biomass substitution (Vande Walle, et al., 2007). However, the long-term carbon balance of these systems depends on the end-use pathway: conversion of biomass into durable wood products or long-lived infrastructure extends the carbon storage timeframe, whereas combustion for energy yields immediate CO_2 release to the atmosphere unless offsetting fossil fuel consumption (Carlisle, et al., 2023).

Moderate-intensity management approaches offer compelling advantages by balancing conservation and production objectives, providing intermediate performance between high-intensity systems and set-asides. Close-to-nature management practices demonstrate substantially superior carbon sequestration performance in temperate European forests, with managed forests under moderate-intensity practices showing higher productivity capacity and larger potential carbon storage pools (Ameray, et al., 2021). Light selective harvesting maintains continuous forest cover while preserving long-lived structural elements essential for both wildlife habitat and ecosystem function—all while sustaining timber production. Forests managed with restraint store significantly more soil carbon than recently managed forests (Moktan, et al., 2025).

Uneven-aged management systems are increasingly adopted in Central European beech forests, where research comparing different management intensities shows these approaches can be effective at both ecological and economic scales (Schall, et al., 2018). Continuous-cover forestry maintains tree cover and structural heterogeneity while deliberately retaining habitat trees and dead wood, supporting biodiversity and ecosystem functioning across temperate regions (Gustafsson, et al., 2020).

In Wallonia, this understanding has translated into policy reform, with forest management shifting since 2016 toward multi-aged, multi-layer and multi-species systems centered on native oaks, using selective thinning cycles of 8 years to maintain continuous forest cover (Gembloux Agro-Bio Tech, AWAC, SPW, dOMG, VMM, ANB, IBGE-BIM, 2019). Comparative studies across Central European beech forests reveal that a landscape-scale mosaic of different stand structures and age-classes promotes regional biodiversity more effectively than dense single-stand heterogeneity, suggesting that variability in forest structure across the landscape should guide conservation strategies (Schall, et al., 2018).

The EU Biodiversity Strategy explicitly recommends expanded adoption of close-to-nature forestry as a biodiversity-friendly practice, positioning these moderate-intensity systems as essential for achieving multifunctional European forest management that balances timber production with climate resilience and conservation objectives (Mason, et al., 2022).

This widespread adoption of selective harvesting demonstrates that carbon-conscious management patterns can be operationally integrated into commercial forestry, achieving substantial carbon benefits compared to high-intensity regimes while simultaneously balancing timber production objectives with ecosystem carbon conservation.

Table 57: Management and Structural Factors Influencing Carbon Sequestration.

Factor	Description	Impact	Quantitative Effect	Source
Complex vs Simplified Stand Structure	Structurally complex forests with multiple layers and species distribute disturbance impacts across functional groups, enabling rapid recovery and stable long-term carbon storage.	+	Complex stands recover within 30 years vs substantially delayed recovery in monocultures; ~50% of soil carbon variability explained by structure	Vandekerkhove et al. 2016; Senf et al. 2020; Cerioni et al. 2024
Set-Aside vs Intensive Management	Unmanaged and moderately managed forests substantially outperform intensive harvesting regimes in carbon sequestration.	+/−	-6.6 tCO_2eq/ha/yr (set-aside) vs -4.8 (active); 38% advantage for low management	Vanhellemont et al. 2024
Intensive Harvesting Impacts	Heavy biomass removal and soil disturbance cause substantial carbon losses across organic horizons and deep soils.	−	−37% forest floor carbon; −7% deep soil loss; 521–1822 t CO_2eq loss in Europe depending on conversion scenario	Achat et al. 2015; Pan et al. 2024

Shorter Harvest Rotation Cycles	Accelerated growth in young forests offsets cumulative carbon storage losses from frequent disturbance and soil carbon decline; outcomes depend on site productivity and management intensity.	+/-	60-year rotations optimal on productive sites; 80–120 years on less productive sites. Frequent soil disturbance results in net ecosystem carbon losses; EU forest carbon removals declining.	Carlisle et al. 2023; Moktan et al. 2025; EEA 2024
Close-to-Nature & Selective Harvesting	Light selective harvesting and continuous-cover forestry maintain structural diversity and carbon stocks while enabling timber production.	+	Superior carbon sequestration vs recent management; significantly more soil carbon than recently managed forests	Ameray et al. 2021; Moktan et al. 2025; Gustafsson et al. 2020

4.4.4 Disturbance Regimes

Beyond management-mediated factors lie external constraints largely beyond human optimization: disturbance regimes—including drought stress, pest outbreaks, and windthrow—that fundamentally override incremental gains from silvicultural practices and operate as overarching controls on realistic carbon sequestration trajectories.

4.4.4.1 Drought and Thermal Stress

Disturbance events—including drought stress, pest outbreaks, and windthrow—represent critical external constraints on forest carbon sequestration that fundamentally limit both the rate and duration of carbon accumulation. Unlike management interventions that can theoretically be optimized, disturbance regimes operate as uncontrollable drivers that can overwhelm incremental gains from management practices on undisturbed sites. Consequently, disturbance frequency and severity have become organizing principles for understanding realistic long-term carbon sequestration trajectories in European forests.

Large-scale modeling indicates that disturbances will reduce Europe's forest carbon storage potential by approximately 1846 Mt CO_2eq during 2021–2030, substantially offsetting management strategies designed to enhance sinks (Seidl, et al., 2014). Belgian have experienced such acute disturbance impacts in recent years. As of 2023, 46% of deciduous and 42% of coniferous trees in Belgium displayed abnormal defoliation, indicating widespread physiological stress from compounding drought and heat conditions (Direction de l'état environnemental (DEE), 2024).

The 2018 drought provides a concrete example of disturbance magnitude on Central European forest ecosystems. Negative drought impacts on forests affected an area 1.5 times larger than the previous severe drought of 2003 and were significantly more severe during peak drought conditions (Buras, et al., 2020). For European beech forests specifically, the 2018 drought was characterized by severe growth reductions, early leaf senescence, leaf browning, and widespread diebacks across Central Europe, representing the most geographically extensive and intense drought event on this species in recent decades (Rukh, et al., 2023). Forest ecosystems experienced declines in gross primary productivity of approximately 10% during the summer drought (Fu, et al., 2020). The physiological recovery of trees was severely impaired after the 2018 drought event, leaving affected forest populations highly vulnerable to secondary disturbances such as insect and fungal pathogen attacks (Schuldt, et al., 2020).

Post-disturbance forest recovery trajectories vary substantially with species composition and forest structure (Anderegg, et al., 2015; Hérault & Piponiot, 2018). While some forests rebound rapidly under favorable conditions, particularly those with advance regeneration present (Seidl et al. 2024), others exhibit legacy effects—reduced growth and incomplete recovery—persisting 1–4 years post-drought (Anderegg, et al., 2015; Müller & Bahn, 2022). Monocultures and low-biomass stands show substantially delayed recovery compared to diverse, multi-species forests, as the limited species pool and reduced regeneration capacity in plantations constrain successional dynamics. Structurally diverse forests with mixed tree sizes, multiple species, and retained deadwood recover canopy cover within 30 years following major disturbances at substantially higher rates than simplified monocultures (Senf, et al., 2020; Cerioni, et al., 2024). This resilience differential reflects fundamental structural constraints: complex forests distribute disturbance impacts across diverse functional groups, enabling rapid compensatory growth, while monocultures lose their entire carbon-fixing capacity simultaneously.

4.4.4.2 Compound Disturbances: Pest Outbreaks in Stressed Systems

Bark beetle outbreaks represent an emerging disturbance driver of particular concern for coniferous monocultures. Drought-stressed trees become substantially more susceptible to pest infestations through immunocompromise mechanisms, creating compound vulnerabilities where stress-induced predisposition enables pest population eruptions (Dendoncker, et al., 2025; Forzieri, et al., 2022; Latte, et al., 2020). In monoculture stands, bark beetle populations can transition from endemic phases confined to windthrown trees to epidemic phases capable of mass-attacking healthy forests, achieving landscape-scale synchronization and catastrophic carbon losses (Seidl, et al., 2024). A managed Austrian mountain forest following windthrow and bark beetle abatement experienced 33% reduction in aboveground carbon stocks, with correlated 31% and 29% declines in net primary productivity and litterfall (Kobler, et al., 2015). Conversely, mixed-species stands provide natural pest resistance through reduced host availability and increased predator habitat diversity, substantially reducing outbreak severity and spatial extent.

Table 58: Disturbance Factors Influencing Carbon Sequestration.

Factor	Description	Impact	Quantitative Effect	Source
Drought & Heat Stress	Prolonged drought reduces photosynthesis and growth while leaving trees physiologically weakened and vulnerable to secondary pests for 1–4 years post-event.	−	2018 drought affected 1.5× more area than 2003; ~10% Gross Primary Productivity loss during peak drought; 46–42% abnormal defoliation in Belgium 2023	Buras et al. 2020; Fu et al. 2020; Theyskens et al. 2024
Compound Disturbances & Pest Outbreaks	Drought-stressed trees become immunocompromised, triggering bark beetle eruptions that cause catastrophic carbon losses, especially in monocultures lacking pest resistance.	−	33% aboveground carbon reduction in managed Austrian forest; 31% net Primary Productivity decline; 29% litterfall decline	Kobler et al. 2015; Dendoncker et al. 2025
Disturbance Recovery Trajectories	Structurally diverse forests with mixed species recover canopy cover and carbon stocks rapidly, while monocultures with limited regeneration capacity show prolonged recovery.	+/−	Complex forests recover within 30 years at substantially higher rates; monocultures show severely delayed recovery; general disturbance reduces European carbon ~1846 Mt CO_2eq (2021–2030)	Senf et al. 2020; Cerioni et al. 2024; Seidl et al. 2014

4.4.5 Atmospheric CO_2 Fertilization

Unlike the direct drivers above, atmospheric CO_2 concentration acts as a modulating factor that can enhance or constrain sequestration rates depending on nutrient and water availability. Atmospheric CO_2 concentration increases over recent decades may enhance forest productivity through improvements in photosynthetic efficiency and water-use efficiency, potentially moderating carbon sequestration across temperate European forests. However, the net effect remains highly uncertain and contingent on nutrient and water availability.

Simulation modeling of mixed broadleaved forests in Wallonia (Belgium) using the HETEROFOR growth model demonstrates that CO_2 fertilization exerts a strong positive impact on net primary productivity when modeled in isolation. However, this theoretical productivity enhancement is substantially modulated by site characteristics, with soil and stand properties accounting for 56–73% of the variability in forest responses across different environmental conditions. Process-based projections for the region suggest that under higher greenhouse gas emission scenarios, forests receiving time-dependent atmospheric CO_2 increases show substantially elevated net primary production, though the magnitude varies considerably depending on local hydrological conditions and soil fertility (de Wergifosse, et al., 2020).

Nitrogen availability emerges as a critical constraint on CO_2 fertilization effectiveness. Meta-analyses of European forest studies quantify the relationship between nitrogen addition and carbon sequestration: above-ground biomass typically accumulates at rates of 15–40 kilograms carbon per kilogram of nitrogen added to forest ecosystems (de Vries, et al., 2009). Notably, recent trend analysis across European forests reveals declining foliar nutrient concentrations. Forest foliar concentrations of N, P, K, S and Mg decreased significantly in Europe by 5%, 11%, 8%, 6% and 7%, respectively during the last three decades, with increasing atmospheric CO2 concentration well correlated with the decreases in N, P, K, Mg, S concentrations and the increase of N:P ratio. This pattern suggests that increased CO_2 drives dilution of foliar nutrient concentrations, creating a physiological constraint that limits the sustained expression of CO_2 fertilization benefits—a mechanism termed nutrient downregulation. The foliar N:P ratio increased everywhere by an average of 7%, further indicating emerging nutrient imbalances that may restrict the capacity for additional carbon assimilation (Peñuelas et al., 2020).

While elevated CO_2 enhances water-use efficiency under optimal conditions, this advantage diminishes under drought, as drought stress reduces photosynthetic gains through stomatal and non-stomatal limitations (Li, et al., 2021). Global satellite observations from 1982 to 2015 revealed declining CO_2 fertilization effects correlated with soil water availability limitations (Wang, et al., 2020). For Atlantic Europe, climate projections indicate extreme heat and drought typical of end-of-century conditions could reach 1-in-10 likelihoods by the 2030s, with Europe-wide 5-year megadroughts becoming plausible by 2050-2074 (Suarez-Gutierrez, et al., 2023). Nitrogen limitation represents an equally critical constraint: a landmark 11-year FACE experiment showed forest productivity enhancement declined from 24 percent to 9 percent by 2008 due to declining nitrogen availability (Norby, et al., 2010), while a global synthesis of 138 experiments confirmed nitrogen limitation drives CO_2 fertilization in approximately 65 percent of global vegetation (Terrer, et al., 2019). Belgian forests exemplify these constraints: simulations showed strong CO_2 fertilization, but empirical carbon sequestration rates were only -0.07 kg C/m²/yr between 1984-2000 (de Wergifosse, et al., 2020). The combined constraints of nitrogen limitation and intensifying water stress suppress productivity responses to atmospheric CO_2 enrichment, explaining modest empirical sequestration rates despite theoretical CO_2 benefits.

Table 59: Fertilization Factors Influencing Carbon Sequestration.

Factor	Description	Impact	Quantitative Effect	Source
CO_2 Fertilization Potential	Elevated CO_2 theoretically enhances productivity through improved photosynthetic efficiency, but this benefit is highly variable and modulated by site conditions.	+ (Unclear)	Strong positive in isolated model; site characteristics explain 56–73% of response variability	De Wergifosse et al. 2020
Nitrogen Limitation	Nutrient-poor conditions dramatically constrain the	−	15–40 kg carbon per kg N added; foliar N −5%, P −11%, K −8% over 3 decades;	De Vries et al. 2009; Peñuelas et

	sustained expression of CO_2 fertilization benefits; European foliar nutrients declining while CO_2 rises (nutrient downregulation).		FACE experiment showed productivity enhancement declined from 24% to 9% due to N limitation; ~65% of global vegetation N-limited	al. 2020; Norby et al. 2010; Terrer et al. 2019
Water Availability Constraint	CO_2 fertilization benefits diminish under drought stress as stomatal and non-stomatal limitations suppress photosynthesis and water-use efficiency gains.	−	Declining CO_2 fertilization correlated with soil water limitations; empirical sequestration only -0.07 kg C/m²/yr despite theory	Li et al. 2021; Wang et al. 2020; De Wergifosse et al. 2020

4.4.6 Harvested Wood Products and Carbon Storage

Although this report assumes that all harvested wood products (HWP) result in direct emissions, reality is more nuanced. The climate impact of forest harvesting extends beyond standing timber to encompass the fate of harvested wood products. While conventional forest carbon accounting often treats harvest as an immediate emission event, wood products continue to store carbon and provide climate benefits long after leaving the forest. Three fundamental factors determine the net climate impact of HWP: processing intensity, storage duration, and material substitution potential.

Processing intensity refers to the energy required to transform raw timber into finished products. Minimal processing operations—such as converting roundwood to sawnwood—require relatively low energy inputs: air-dried sawnwood consumes 0.07-0.11 GJ/m³ (0.14-0.22 GJ/t) for softwood and hardwood respectively) (FAO 1990). In contrast, highly processed products like pulp and paper demand substantially greater energy consumption. Kraft pulping, the dominant chemical pulping process, consumes approximately 14.3 GJ per tonne for virgin pulp, with energy requirements dropping to 0.7-3 GJ per tonne when using recovered fiber (Industrial Efficiency Technology & Measures 2014). This processing energy, typically derived from fossil fuels or biomass combustion, generates immediate CO_2 emissions that must be deducted from the product's climate benefit.

Storage duration determines how long harvested carbon remains sequestered in products before returning to the atmosphere through degradation, combustion, or decomposition. The IPCC (2019) provides standardized half-life values for different product categories: sawnwood used in construction has a 35-year half-life, wood panels 25 years, pulp and paper products 2 years, and wood fuel experiences immediate release upon combustion. These differences are dramatic—a cubic meter of timber converted to construction lumber may store carbon for decades, while the same volume processed into paper returns its carbon to the atmosphere within years. Storage duration thus represents the temporal dimension of the carbon benefit.

Material substitution potential captures the avoided emissions when wood products replace more carbon-intensive materials. Each tonne of sawnwood used in construction displaces approximately 0.5-1.5 t CO_2eq from avoided production of concrete, steel, or masonry, yielding combined benefits of 2.3-3.3 t CO_2eq per tonne when storage and substitution are summed (Leskinen et al. 2018). Wood panels similarly displace plastics, composites, and metal products. In contrast, pulp and paper products offer minimal substitution benefits, as few alternative materials exist for their applications, and wood fuel's substitution is limited to fossil fuel displacement in energy generation. The substitution effect means that optimal climate outcomes require not only harvesting sustainably but also directing timber toward applications where it delivers maximum displacement value.

These three factors interact to create a hierarchy of climate performance across product categories. Products combining low processing intensity, long storage duration, and high substitution potential—particularly sawnwood for construction—deliver superior climate benefits. Conversely, products requiring intensive processing, offering short storage, and providing minimal substitution—such as pulp and paper—generate substantially lower net climate value per unit of harvested timber.

4.4.6.1 Belgium's HWP Profile and Climate Performance

Data sources and analytical approach. This analysis draws on FAO Forest Products Statistics (FAO, 2025) for Belgium covering 2000-2023, encompassing 48 distinct product categories across production, import, and export flows. To avoid double-counting, intermediate products—industrial roundwood, pulpwood, sawlogs, and raw wood residues—were excluded, as these materials are transformed into finished products already captured in the dataset. Products were classified into five final categories: (1) Sawnwood (construction lumber), (2) Wood Panels (plywood, MDF, OSB, fibreboard, veneer sheets), (3) Pulp & Paper (all pulps, papers, and recovered paper), (4) Wood Fuel (pellets, briquettes, charcoal, fuel wood), and (5) Wood-Based Panels & Residues (particle board and wood chips/particles used in panel production).

Since FAO reports products in both volume (m³) and weight (tonnes), volume-based measurements were converted to weight equivalents using standardized density factors: sawnwood 0.50 t/m³ (air-dried lumber), wood panels 0.60 t/m³ (compressed products), and mixed wood products 0.658 t/m³ (production-weighted average). These conversion factors, based on (FAO et al. 2020) standards and calibrated to Belgian forest composition (59% deciduous, 41% coniferous), ensure all production figures are expressed in consistent weight units.

Current production profile. Belgium's harvested wood products represent a critical component of the national forest carbon cycle. Current production (2023) stands at 7.79 Mt annually, distributed across five product categories with dramatically different climate implications: pulp and paper (4.61 Mt, 61%), wood-based panels and residues (1.30 Mt, 17%), wood fuel (0.77 Mt, 10%), sawnwood (0.73 Mt, 9%), and wood panels (0.38 Mt, 5%). These volumes aggregate weight-measured products (like pulp, reported directly in tonnes) with volume-measured products (like sawnwood, reported in m³ then converted to tonnes using 0.50 t/m³ density for air-dried lumber).

This product portfolio reveals profound inefficiency from a climate perspective when examined through the three key factors:

- Storage duration. Roughly 71% of Belgium's wood production achieves only short-term storage (≤10 years) or immediate release. The dominance of pulp and paper (61% of production) means the majority of harvested wood flows into products with 2-year half-lives according to IPCC (2019) guidelines. Meanwhile, long-term storage products—sawnwood (35-year half-life) and wood panels (25-year half-life)—represent merely 29% of current production (approximately 1.1 Mt combined annually). This concentration in short-lived products fundamentally limits the duration for which harvested carbon remains sequestered.
- Processing intensity. Heavy concentration in pulp and paper reflects historical industrial development and creates substantial processing emissions. The majority of Belgium's wood products undergo very high-intensity processing, with kraft pulping consuming 14.3 GJ per tonne for virgin pulp. This energy-intensive transformation generates immediate CO_2 emissions that compound the climate constraint created by paper's short storage duration.
- Material substitution potential. Belgium's production portfolio severely underutilizes the opportunity to displace carbon-intensive materials. Only 13% of production consists of high-substitution products (sawnwood and wood panels) capable of replacing concrete, steel, and other construction materials. While timber-framed construction reduces building embodied carbon by 30-50% compared to conventional

materials, Belgium directs minimal production toward these applications. Conversely, pulp and paper (61% of production) offers minimal substitution potential, as few alternative materials exist for paper applications.

This threefold misalignment—between harvest volumes and storage duration, processing efficiency, and substitution opportunity—substantially limits the sector's contribution to national carbon sequestration goals. Belgium's HWP sector faces structural constraints rooted in processing infrastructure and market demand that perpetuate this inefficiency.

4.4.6.2 Trade Position

Belgium currently functions as a net importer of wood products (approximately 1.3 Mt annually based on 2023 data). Trade volumes were calculated using identical product filtering and weight conversion methodologies as production data. This position externalizes processing emissions to supplier countries while Belgium captures storage and substitution benefits domestically. Cumulative trade data over 2000-2023 reveal total imports of 316.0 Mt and exports of 284.3 Mt, yielding net imports of 31.7 Mt.

Trade patterns vary significantly by product category: Belgium exports wood-based panels and residues (net exports of 10.8 Mt cumulatively), indicating domestic processing strength, while importing sawnwood (net imports of 12.3 Mt), wood fuel (10.7 Mt), pulp and paper (5.4 Mt), and other products (13.9 Mt). The net import of sawnwood—which offers superior climate benefits through long storage and high substitution potential—suggests untapped potential for expanding domestic construction timber production, which would capture both the processing value-added and the full climate benefits of long-storage, high-substitution products.

4.4.6.3 Temporal Trends (2000-2023)

Analysis of trends over the study period reveals modest improvements in product mix despite stable production volumes. Annual output declined marginally from 7.92 Mt in 2000 to 7.79 Mt in 2023 (-1.7%). The product mix shifted slightly toward long-term storage products, which increased from 30.9% to 31.2% of production (+0.3 percentage points). Conversely, the share of very high processing intensity products (primarily pulp and paper) declined modestly over the period.

Cumulatively over 2000-2023, Belgium produced 198.4 Mt of final wood products. The production profile remained heavily weighted toward pulp and paper (121.9 Mt, 61.5% of cumulative total), with long-term storage products (sawnwood 17.6 Mt and wood panels 9.2 Mt) representing just 13.4% of cumulative production. This temporal analysis suggests gradual but infrastructure-constrained sector evolution, though the pace of change in product mix composition remains modest.

4.4.6.4 Policy Implications

Maximizing climate benefits from forest harvesting would require incentivizing shifts toward long-storage construction products and developing processing infrastructure for mass timber and engineered wood products to capture domestic timber opportunities and import substitution potential.

4.5 Feasibility of Forest Carbon Sequestration Enhancement

The preceding scenario analysis demonstrates that Belgium can achieve substantial increases in carbon sequestration through targeted forest expansion. This section assesses implementation feasibility across four critical dimensions: biophysical capacity (land availability), institutional structures, financial resources, and technical expertise. By evaluating constraints and opportunities across these areas, the analysis identifies primary barriers to translating sequestration targets into on-the-ground forest expansion and determines which limitations are fundamental versus addressable through policy decisions and institutional development.

4.5.1 Biophysical Potential for Forest Expansion

Assessment using global tree restoration models reveals substantial opportunities for forest expansion beyond Belgium's current boundaries. Wallonia exhibits the highest average potential at 38.3% tree cover in non-forest areas, while Flanders demonstrates 27.1% potential. Agricultural land conversion represents the largest opportunity, with 532.33 kha of potential across Belgium—Wallonia contains 311.16 kha (58.4%) and Flanders 220.62 kha (41.4%) (Bastin, et al., 2019). Against these biophysical constraints and opportunities, the proposed scenarios represent only a fraction of available potential: the current policy scenario targets 18 kha new afforested land and the major change scenario targets 80 kha. Both scenarios are biophysically feasible, as they require conversion of less than 3% and 16% of available suitable agricultural land respectively (Bastin, et al., 2019), without requiring conversion of protected lands or ecologically sensitive areas.

While the biophysical potential clearly exists, realizing the current policy scenario, and to a larger extent the major change scenario, would necessitate a fundamental departure from established land-use patterns, requiring sustained political commitment and investment substantially exceeding historical precedent. Belgium's forest surface remained largely stable between 2000 and 2024, fluctuating minimally between -0.082% and +0.044% per year (see §4.1.1). The current policy scenario, targeting 18 kha over 25 years, aligns with the upper bound of this historical range with a required increase of 0.045% per year. The major change scenario, by contrast, would represent a tenfold increase relative to Belgium's highest past afforestation rate estimates (+0.45% per year). Therefore, achieving either scenario would demand more than biophysical suitability; it requires transformative shifts in land governance and agricultural policy, sustained institutional commitment, and investment levels unprecedented in recent Belgian history to overcome deeply rooted competing interests in land allocation.

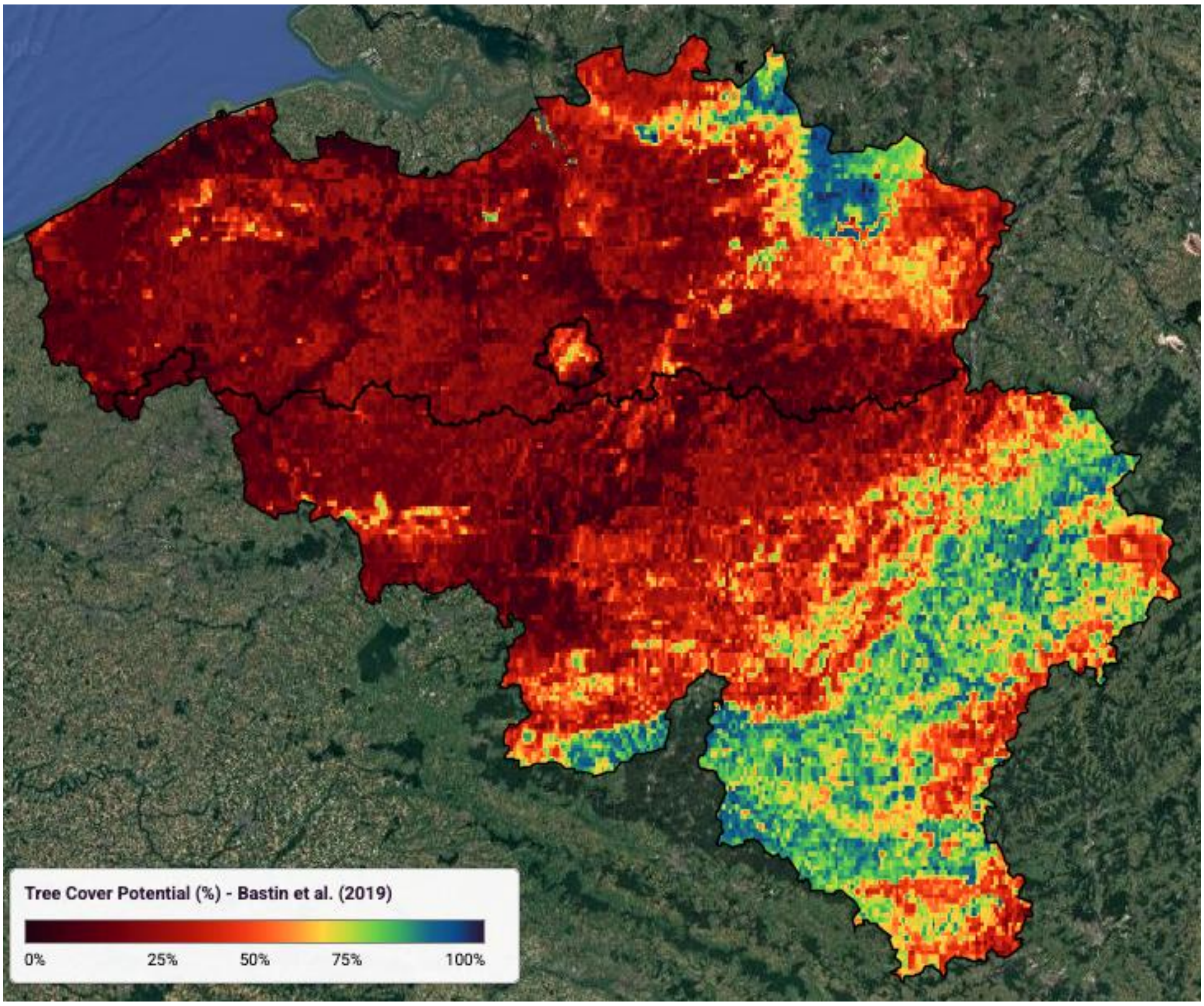


Figure 36: Forest Cover Potential in Belgium (Bastin, et al., 2019).

4.5.2 Institutional Framework

Belgium's federal governance structure presents both opportunities and significant constraints for coordinated forest enhancement. The assignment of forest policy to three independent regional governments enables regionally tailored approaches responsive to local conditions but fragments authority in ways that complicate landscape-scale interventions requiring cross-regional coordination.

Wallonia demonstrates a strong framework for forest enhancement. The region has established the Forêt Résiliente (Resilient Forest) initiative, explicitly targeting forest adaptation to climate change through promotion of mixed-species stands and diversified management approaches (Direction de l'état environnemental (DEE), 2024; Filière Bois Wallonie, 2024). This flagship program sets concrete objectives including transitioning 25% of forest area to resilient management by 2050, providing institutional mechanisms for coordinating regional forest policy around biodiversity and carbon sequestration objectives. The recently revised Wallonian Forest Code actively promotes mixed-species forests and sustainable management practices, with certification schemes covering 95% of public forests driving improved practices through third-party verification and market incentives (Direction de l'état environnemental (DEE), 2024; Filière Bois Wallonie, 2024).

Flanders demonstrates genuine policy commitment through inclusion of forest enhancement in biodiversity strategies and recent reductions in proposed urban development to achieve zero net land take by 2040—a timeline more aggressive than Wallonia's 2050 target (Verdonck, et al., 2025; Poelmans & Verheyden, 2023). These policy commitments reflect serious regional intent to advance forest enhancement objectives.

Implementation in Flanders, however, faces greater structural complexity than Wallonia, though both regions confront private forest ownership challenges. Wallonia's 51% private forest ownership creates coordination difficulties with landholders holding heterogeneous objectives and limited incentives for participation. However, Flanders faces substantially more acute institutional complexity due to extreme forest fragmentation combined with higher private ownership (64%), where holdings are dispersed into numerous small parcels rather than consolidated management units (Fillière Bois Wallonie, 2024; Verdonck, et al., 2025). This magnified fragmentation in Flanders creates institutional bottlenecks that policy commitment alone cannot overcome, requiring fundamentally different coordination mechanisms and resource investments than Wallonia's more manageable private ownership challenge.

Brussels maintains institutional capacity for coordinated management through its 95% public forest ownership. However, Brussels faces uniquely severe constraints from its densely developed metropolitan context, with severely limited expansion opportunities and pressing urban interface pressures. These spatial realities substantially constrain the region's capacity to contribute meaningfully to landscape-scale forest enhancement, despite institutional advantages.

Private forest owner engagement represents an acute institutional challenge. Current policy approaches rely primarily on voluntary participation in enhancement programs, with variable uptake rates limiting implementation pace (Pisman & Bieseman, 2024). Institutional mechanisms including forest owner cooperatives, simplified regulatory procedures, and regional forest plans that lower coordination barriers for small owners could enhance participation rates but require resources for establishment and operation.

While regional policy frameworks demonstrate genuine commitment to forest enhancement and substantial progress has been achieved, implementation faces notable barriers. While the proposed scenarios represent modest targets relative to biophysical potential, their implementation would require substantially greater institutional effort than historical precedent. The major change scenario, requiring 3,200 ha annually, represents a tenfold increase relative to Belgium's highest past afforestation rates, demanding significant institutional expansion building upon existing programs and administrative capacities within each region. Full implementation depends on strengthening mechanisms for private landowner engagement through policy and resource allocation.

Achieving the Major Change Scenario would demand more than institutional feasibility; it requires transformative shifts in land governance and agricultural policy, sustained institutional commitment, and investment levels unprecedented in recent Belgian history. Success requires targeted institutional investment in enhanced support for private landowner participation, moving beyond voluntary approaches toward more structured incentive frameworks.

4.5.3 Capacity Building

Belgium's forest enhancement ambitions depend critically on substantial expansion of technical expertise and support systems. Belgium employs approximately 500–1,000 professional foresters, predominantly in public agencies or large private holdings (De Keersmaeker, et al., 2015). This limited workforce faces particular constraints given the fragmented private ownership structure across both Wallonia and Flanders, where small holdings predominate.

Meeting implementation demands requires two complementary investments: dramatically expanded technical assistance and enhanced professional training.

Small private forest owners require accessible guidance to implement mixed-species management and adaptive silvicultural practices. Extension services must scale substantially to reach dispersed smallholders unable to access specialized forestry consultation independently. Regional cooperation models, as demonstrated in Flanders through the establishment of Forest Groups, can efficiently pool resources among small owners and facilitate knowledge exchange. The 11 active Forest Groups in Flanders, with nearly 13,000 members representing approximately 13% of all forest owners, provide coordinated management of forest parcels along with professional expertise, administrative support, coaching, and technical assistance (EVENOR - TECH, 2021). These cooperative structures demonstrate that investment in extension capacity represents the primary barrier to smallholder participation, particularly for scenarios requiring coordinated management across thousands of small parcels.

University-level forestry education in Belgium must continue to evolve to emphasize mixed-species management, irregular forest structure development, and adaptive management methodologies—skills essential for ecologically-based forest transition. Belgian institutions are well-positioned to advance this evolution and provide a foundation upon which curricula can be expanded and specialized to meet landscape-scale implementation needs. Strengthening such programs through targeted investment in faculty, research infrastructure, and field facilities represents a feasible pathway to developing the specialized expertise required for mixed-species and adaptive silvicultural practices across Belgium's forest landscape. Importantly, expanding formal forestry curricula and professional development programs requires only modest incremental investment relative to total implementation costs, while competitive market advantages provide private incentives for skill acquisition among forestry professionals.

While meeting major change scenarios would require training hundreds of additional forestry professionals and extension staff, this expansion remains feasible within existing institutional frameworks. The technical capacity challenge is fundamentally addressable through targeted investment in human capital development and support infrastructure. The successful establishment of cooperative forest management structures in Flanders and the availability of high-quality forestry education programs across Belgium demonstrate that both extension capacity and professional training pipelines can be effectively scaled to meet Belgium's forest enhancement objectives.

4.5.4 Financing & Incentives

Belgium's forest expansion will require substantial and sustained financial investment, with multiple cost categories each demanding significant funding. While a comprehensive financial estimate extends beyond this study's scope, key cost components can be identified and evaluated.

The most economical afforestation strategy capitalizes on natural regeneration on abandoned agricultural land. Both Wallonia and Flanders possess substantial natural regeneration potential, offering low-cost pathways where ecological succession can establish forest cover with minimal intervention. Conversely, afforestation on currently productive agricultural land faces considerable opportunity costs, as foregone agricultural revenue must be compensated. With average Belgian agricultural land rent ranging from €294–343 per hectare annually, this represents the primary financial constraint for conversion scenarios (Statbel, 2025).

Beyond land acquisition, transitioning existing forests to ecologically-based management requires targeted silvicultural interventions. Standard operations such as selective thinning and mixed-species introduction typically cost €150–500 per hectare, while more complex interventions range from €500–2,000 per hectare. These investments form the backbone of ecological forest transformation (Di Fulvio & Lessa, 2025).

Since Belgium's forests remain largely privately owned, ecosystem service payment schemes targeting private forest owners will become essential to incentivize ecological management. These schemes typically provide €100–300 per hectare annually for conservation activities including mixed-species management. Market-based mechanisms such as forest certification offer supplementary financial incentives, collectively helping to offset implementation costs (Gembloux Agro-Bio Tech, AWAC, SPW, dOMG, VMM, ANB, IBGE-BIM, 2019; Wunder, 2024).

Realizing landscape-scale enhancement requires significant investment in human capacity and institutional infrastructure. This includes recruitment and training hundreds of full-time positions, establishment of demonstration forests, and development of learning networks. These initiatives represent substantial recurring expenditure, particularly during intensive implementation phases and remain critical for long-term success.

The scenarios under consideration—involving from 18 kha to 80 kha hectares of major forest change—translate these per-hectare costs into multi-hundred-million-euro financing requirements. While substantial, such investment remains achievable through innovative mechanisms including carbon credit monetization and international climate finance. Indeed, financial resources will be necessary for implementation success and to maintain sustained engagement with stakeholders to address local concerns and build the broad support necessary for achieving these expansion goals.

4.6 Co-Benefits of Forest Carbon Enhancement

While carbon sequestration provides the primary justification for large-scale forest enhancement, comprehensive analysis reveals substantial co-benefits extending across ecosystem services, biodiversity conservation, and climate resilience. These co-benefits emerge from fundamental ecological processes: the same management approaches and landscape characteristics that enhance carbon storage simultaneously improve forest stability under climate stress, support specialist species recovery, and provide multiple ecosystem services. Understanding these synergies strengthens the economic case for forest enhancement and demonstrates alignment between climate mitigation and broader environmental sustainability objectives.

4.6.1 Climate Resilience and Disturbance Recovery

Forest resilience—the capacity to maintain ecological function and recover from disturbance—represents a critical co-benefit arising from management extensification and structural diversity enhancement. Climate change projections indicate accelerating frequency and intensity of drought stress, pest outbreaks, and extreme weather events, making resilience essential for maintaining forest carbon storage and ecosystem services.

Structural and compositional diversity enhance climate resilience through multiple complementary mechanisms. Mixed-species stands demonstrate greater stability under climate variability through compensatory growth, where drought-tolerant species maintain productivity while drought-sensitive species experience reduced growth, generating higher overall stand productivity during stress periods (Vannoppen, et al., 2020). Research in Belgian temperate forests has shown that mixed-species stands with complementary drought strategies can stabilize productivity (Vanhellemont, et al., 2019; Sousa-Silva, et al., 2018).

Recovery capacity following disturbance varies dramatically among forest types with major implications for long-term ecosystem stability. While most forests recover canopy cover within 30 years following disturbance (Senf & Seidl, 2021), recovery rates are substantially higher in structurally diverse, mixed-species forests compared to simplified monocultures. Forest recovery following bark beetle disturbances in Norway spruce monocultures illustrates these differences. Early recovery stages show tree seedling and sapling regeneration within years of infestation, though recovery trajectories diverge significantly based on management approaches (Mayer, et al., 2022). Forests subjected to salvage logging show delayed recovery compared to naturally developing stands, as salvage logging removes deadwood that serves as an important substrate for spruce regeneration and may damage advance regeneration (Priewasser, et al., 2013). Furthermore, salvage logging operations compact soil and suppress mycorrhizal fungal activity essential for seedling establishment (Mayer et al., 2022).

Under climate change conditions, the post-disturbance reorganization period is pivotal in determining whether recovery results in compositional persistence or fundamental structural and compositional shifts, with species-poor monocultures particularly susceptible to permanent compositional changes.

Management approaches can enhance forest resilience by retaining structural diversity and increasing landscape-scale heterogeneity to improve recovery trajectories. Retention of deadwood in post-disturbance stands maintains fungal communities that facilitate regeneration and provides insurance against carbon storage losses during extreme disturbance events under projected climate warming scenarios (Mayer, et al., 2022; Priewasser, et al., 2013).

Strategic species selection toward climate-adapted alternatives provides additional resilience enhancement. Small-leaved lime demonstrates substantially greater drought tolerance compared to beech while providing similar carbon storage capacity (Latte, et al., 2020). Oak species, resilient across climate gradients, offer multiple ecosystem functions including wildlife habitat and carbon storage (Direction de l'état environnemental (DEE), 2024). Transition toward these resilient species combinations reduces long-term vulnerability to climate-driven mortality, maintaining forest cover and carbon stocks under changing conditions.

4.6.2 Biodiversity Conservation and Species Recovery

Biodiversity conservation represents a critical co-benefit addressing urgent conservation challenges. Unfavorable conservation status affects 43% of native bird species in Wallonia and 95–96% of forest habitat types of community interest, reflecting widespread habitat degradation from structural simplification and fragmentation (Direction de l'état environnemental (DEE), 2024). These deficits stem from decades of intensive forest management that has systematically reduced structural complexity and connectivity across the landscape.

Forest enhancement strategies targeting structural complexity and landscape connectivity offer multi-pathway solutions to these biodiversity deficits. Research across multiple European forest systems demonstrates that structural variation is a key factor explaining the variation in species richness, indicating that structural enhancement provides broad-based biodiversity benefits across plants, birds, arthropods, and fungi (Ampoorter, et al., 2020; Brockerhoff, et al., 2017).

Structural diversity enhancement directly supports specialist species recovery through provision of essential habitat elements. Increasing deadwood volumes from current 10 m^3/ha to recommended 30 m^3/ha levels provides critical habitat for saproxylic (deadwood-dependent) beetles, fungi, and birds currently severely depleted in intensively managed forests (Direction de l'état environnemental (DEE), 2024). Large tree retention, addressing the current absence affecting 78% of deciduous forests, creates specialized microhabitats including cavities, loose bark, and branch complexity that support cavity-nesting birds and specialized arthropods. These structural elements emerge naturally in unmanaged forests and can be maintained through selective harvest approaches preserving the largest individuals and accumulated deadwood.

Species composition transformation toward mixed stands provides complementary biodiversity benefits through enhanced resource complementarity and reduced vulnerability to species-specific threats. Each additional tree species increases plant species richness and associated faunal diversity, with particularly strong effects for bryophytes, lichens, and invertebrates dependent on resource heterogeneity (Ampoorter, et al., 2020). Birds consistently show preference for mixed stands and complex structures over simplified monocultures, with specialist forest species particularly responsive to structural complexity (Oettel & Lapin, 2021).

4.6.3 Landscape Connectivity and Fragmentation Mitigation

Current extreme fragmentation in Belgium severely constrains forest biodiversity, with 70% of forest patches remaining smaller than 5 hectares—a scale that limits population viability and genetic diversity maintenance for forest-dependent species (De Keersmaeker, et al., 2015; Verdonck, et al., 2025). This fragmentation is compounded by structural simplification, with 20–75% of Wallonian forest species declining over the last century (Direction de l'état environnemental (DEE), 2024).

Strategic afforestation through corridor creation offers a dual solution to these interconnected problems. By connecting existing forest patches, corridor networks enable species movement and genetic exchange, directly reducing extinction probability for specialists and facilitating the natural adaptation processes essential for climate change response (Aitken & Whitlock, 2013). Evidence from Eurasian lynx and European wildcat habitat networks demonstrates the conservation value of enhanced landscape connectivity, with Wallonian forests providing strategic connectivity across Western European forest systems and supporting transboundary species conservation objectives (Bourdouxhe, et al., 2020).

Ancient forest specialists—species dependent on long forest continuity and complex stand structures—serve as indicator taxa for assessing both connectivity and management effectiveness (Hermy, et al., 1999). Though these species colonize slowly, rarely exceeding one meter per year (Bossuyt, et al., 1999; Matlack, 1994), recovery is substantially accelerated by enhanced landscape connectivity, as AFS numbers in recent forests are positively influenced by physical contact with ancient forest sources (Honnay, et al., 1999; Bourdouxhe, et al., 2020). Addressing fragmentation and structural simplification through afforestation directly supports recovery trajectories, as stand structural complexity correlates significantly with species richness and management effectiveness (Ehrbrecht, et al., 2017; Storch, et al., 2018), with measurable improvements in forest specialist recovery expected within 20–30 year timeframes as landscapes develop enhanced connectivity and structural complexity (Verheyen, et al., 2006; Brunet, 2007). This timeframe reflects the biological reality of forest ecosystem development while providing landscape-scale biodiversity benefits essential for long-term species persistence, though full recovery of ancient forest species composition requires substantially longer periods—potentially 130–230 years or more (Vellend, 2003).

4.7 Synthesis, Conclusion and Recommendations

4.7.1 Synthesis

Belgian forests operate within a complex landscape of competing management objectives that fundamentally shape carbon sequestration outcomes. Actively managed forests store less carbon than unmanaged systems due to harvesting and soil disturbance. Close-to-nature management approaches, which prioritize continuous forest cover and selective harvesting, offer viable pathways that maintain timber production while substantially improving carbon performance compared to intensive regimes.

Belgium possesses substantial biophysical capacity for forest expansion, with significant areas of suitable agricultural land available. However, realizing expansion scenarios requires institutional transformation, particularly given the extreme fragmentation of private forest ownership. These structural realities define the feasibility boundaries within which forest enhancement pathways must operate.

The third part of the project entailed an analysis of the forestry sector with a view to quantifying the potential of natural carbon sequestration through forest expansion and improved management practices in Belgium.

4.7.1.1 Results

Current situation (S0): Belgium's forests currently sequester **1.59 – 2.12 Mt CO_2eq/yr** (2023-2025 baseline). If conditions remained constant through 2026-2050, this would accumulate approximately **39.75 – 53.00 Mt CO_2eq** over the 25-year period.
Reference scenario (S1): In this scenario, deforestation and afforestation remain balanced at approximately 920 ha per year, maintaining forest cover equilibrium at 710 kha. During the implementation period (2026-2050), carbon sequestration averages **1.65 – 2.21 Mt CO_2eq/yr**, representing a 4% increase compared to S0, due to fast absorbing juvenil forest stand replacing old growth stands. Belgian forests would absorb **1.70 – 2.27 Mt CO_2eq/yr in 2050**. Over the 25-year implementation period, S1 accumulates approximately **41.35 – 55.19 Mt CO_2eq**—representing **1.60 – 2.19 Mt CO_2eq more** than S0. Following cessation of land-use conversion activities after 2050, the scenario exhibits a peak in 2051 (**1.99 – 2.48 Mt CO_2eq/yr**) as juvenile forests mature, before stabilizing by 2070 at **1.88 – 2.34 Mt CO_2eq/yr**.
Current policy scenario (S2): In this scenario, deforestation is reduced while targeted afforestation expands forest cover. Afforestation totals +33 kha nationally (including an additional +10 kha specifically in Flanders), while deforestation continues at -15 kha nationally (an avoided deforestation of 8 kha compared to the reference scenario), resulting in a net expansion of approximately +18 kha, reaching a total forest area of 728 kha by 2050. During implementation (2026-2050), carbon sequestration averages **1.98 – 2.46 Mt CO_2eq/yr**, representing **11–20% higher** sequestration than S1 (**an additional 0.33–0.25 Mt CO_2eq/yr**). By 2050, sequestration reaches **1.93 – 2.52 Mt CO_2eq/yr**. Over the 25-year implementation period, S2 accumulates approximately **49.38 – 61.59 Mt CO_2eq—6.40 - 8.03 Mt CO_2eq more** than S1 and **9.63 – 8.59 Mt CO_2eq more** than S0. Following cessation of afforestation after 2050, the scenario peaks in 2051 at **2.11 – 2.66 Mt CO_2eq/yr**, before stabilizing by 2070 at **1.95 – 2.44 Mt CO_2eq/yr**—representing a **4% gain above S1**.
Major change scenario (S3): In this scenario, zero deforestation is combined with accelerated afforestation of 3200 ha per year, distributed proportionally across regions, expanding forest cover by 80 kha to reach 790 kha by 2050. During implementation (2026-2050), carbon sequestration averages **2.23 – 2.81 Mt CO_2eq/yr**, representing **27-35% more** than S1 (**an additional 0.58–0.60 Mt CO_2eq/yr**) and **13–14% more** than S2 (**an additional 0.25–0.35 Mt CO_2eq/yr**). By 2050, sequestration peaks at **2.48 – 3.14 Mt CO_2eq/yr**. Over the 25-year implementation period, S3 accumulates approximately **55.79 – 70.22 Mt CO_2eq— 14.44 – 15.03 Mt CO_2eq more** than S1 and **16.04 – 17.22 Mt CO_2eq more** than S0. Following cessation of afforestation after 2050, sequestration gradually declines, stabilizing by 2070 at **2.10 – 2.60 Mt CO_2eq/yr**—representing an **11–12% gain above S1**.

4.7.1.2 Discussion

Based on these scenarios, carbon sequestration rates were calculated for both the implementation period (2026-2050) and the long-term stabilization period (post-2070). The conversion of agricultural land (abandoned or marginal cropland) into forest through afforestation allows S2 and particularly S3 to become enhanced carbon sinks compared to the baseline trajectory. This result highlights that strategic forest expansion can increase Belgium's carbon removal capacity while generating substantial co-benefits for climate resilience and biodiversity conservation.
Regarding forest management practices, the study identifies close-to-nature management—emphasizing mixed-species stands, continuous forest cover, and selective harvesting—as

essential for maximizing carbon storage while maintaining timber production. Set-aside (unmanaged) forests demonstrate the highest per-hectare sequestration rates. The transition from intensive to close-to-nature management across Belgium's 710 kha of forest—combined with strategic afforestation—represents the primary pathway for enhancing forest carbon sequestration.

Finally, all three scenarios demonstrate positive co-benefits beyond carbon sequestration. Enhanced forest structural complexity and species diversity improve climate resilience, with mixed species stands showing superior recovery capacity following drought and pest disturbances. Reduced management intensity and strategic corridor afforestation address current biodiversity deficits. These ecosystem service benefits strengthen the case for ambitious forest enhancement, as S3 yields the greatest improvement in both carbon sequestration and ecological resilience.

Achieving S2 would yield a carbon sequestration gains (4% above S1) while institutional capacity would need to be strengthened for more ambitious action. S3, while biophysically feasible and generating superior climate benefits (11% above S1), would require higher political commitment and coordination.

4.7.2 Recommendations

Based on the analysis of Belgium's forest carbon sequestration potential and the constraints identified, five key recommendations emerge for enhancing forest-based climate mitigation while addressing institutional, technical, and financial barriers.

4.7.2.1 Advance Close-to-Nature Forest Management

Belgium should continue and expand close-to-nature management approaches across both public and private forests through targeted policy support. This requires accelerating implementation of regional forest codes prioritizing mixed-species systems and irregular stand structures, coupled with enhanced extension services to support forest owners in transitioning management practices. Demonstration forests and learning networks can showcase performance advantages and build practitioner confidence. Although quantitative studies are scarce in Belgium regarding this matter, a recent comparison of set-aside forests and managed forests in Flanders showed a 38% carbon sequestration advantage for set-aside forests compared to managed forests (Vanhellemont, et al., 2024). Nevertheless, close-to-nature management represents the primary pathway for enhancing carbon sequestration while maintaining timber production, addressing both climate mitigation and economic sustainability objectives.

4.7.2.2 Implement Strategic Afforestation with Ecological Objectives

Afforestation should be concentrated on naturally regenerating abandoned agricultural land, livestock feed grassland, and designated non-productive sites. Where conversion of currently productive agricultural land is necessary to achieve reforestation targets, priority should be given to the least productive cropland—particularly marginal lands with poor soil quality, steep slopes, or degraded conditions that limit agricultural yield. Afforestation must avoid conversion of endangered ecosystems such as calcareous grasslands, and other high-biodiversity grassland habitats. Implementation should prioritize corridor afforestation connecting fragmented forest patches to enhance landscape connectivity, addressing current fragmentation constraints that limit both biodiversity and genetic exchange. Regional governments should jointly develop cross-regional corridor strategies to advance these connectivity objectives across administrative boundaries.

4.7.2.3 Enhance Private Forest Owner Participation

Private forest ownership requires structured engagement mechanisms beyond current voluntary approaches. Belgium should establish or strengthen forest owner cooperatives modeled on successful regional examples, providing professional expertise, administrative support, and coordinated management of dispersed parcels. Simplified regulatory procedures and financial incentives should reduce coordination barriers for small owners. Publicly supported forest expansion should include mandatory participation requirements or enhanced incentives ensuring that afforestation achieves sustainable plantation and ecological objectives.

4.7.2.4 Build Technical and Professional Capacity

Forest enhancement depends on expanding technical expertise across extension services and professional forestry. Investment in university-level forestry education should continue to emphasize mixed-species management, irregular stand development, and adaptive silvicultural practices essential for close-to-nature approaches. Extension services must scale substantially to reach dispersed smallholders currently unable to access specialized forestry consultation independently. While this capacity challenge is substantial—particularly for S3, which would require a tenfold increase in implementation capacity—it remains fundamentally addressable through targeted investment in human capital development.

4.7.2.5 Establish Mechanisms for Collective Afforestation Distribution and Financing

Cross-regional collaboration is particularly essential for implementing the major change scenario, where collective decision-making processes must determine how the 80 kha of required afforestation should be distributed across regions. This allocation should be negotiated through transparent, evidence-based frameworks that consider each region's ecological potential, existing forest cover, available land, and capacity constraints. Innovative financing mechanisms—including, international climate finance, and ecosystem service payments—should be mobilized to sustain implementation across the 25-year timeframes required for landscape-scale transformation.

4.7.3 Conclusion

Belgium's forests represent a substantial yet underutilized carbon sequestration potential, while the resource is facing competing pressures from timber production, biodiversity conservation, and climate resilience objectives. Four critical findings emerge from this analysis.

First, Belgian forests face competing management objectives across timber production, carbon sequestration, recreation, protection, and biodiversity conservation, creating complex tradeoffs in policy formulation and implementation. The quantitative analysis demonstrates that different management and expansion pathways generate meaningfully different carbon sequestration outcomes. During the implementation period (2026-2050), S0 would maintain sequestration at 1.59 – 2.12 Mt CO_2eq/yr, while S1 averages 1.65 – 2.21 Mt CO_2eq/yr (4% above S0). S2 achieves 1.98 – 2.46 Mt CO_2eq/yr (16–25% above S0 and 11–20% above S1), while S3 delivers 2.23 – 2.81 Mt CO_2eq/yr (33–40% above S0 and 27–35% above S1). Over the 25-year implementation period, S1 accumulates 41.35 – 55.19 Mt CO_2eq (1.60 – 2.19 Mt CO_2eq more than S0), S2 accumulates 49.38 – 61.59 Mt CO_2eq (9.63 – 8.59 Mt CO_2eq more than S0 and 8.03 – 6.40 Mt CO_2eq more than S1), while S3 accumulates 55.79 – 70.22 Mt CO_2eq (16.04 – 17.22 Mt CO_2eq more than S0 and 14.44 – 15.03 Mt CO_2eq more than S1). Long-term stabilization (post-2070) shows S1 at 1.88 – 2.34 Mt CO_2eq/yr, S2 achieving modest gains of 4% above S1 (1.95 – 2.44 Mt CO_2eq/yr), and S3 reaching 11–12% above S1 (2.10 – 2.60 Mt CO_2eq/yr). However, these gains require sustained commitment over 25-year timeframes.

Second, extreme forest fragmentation creates substantial barriers to effective carbon sequestration and biodiversity conservation. Belgium's forest landscape suffers from severe spatial fragmentation, with 70% of patches smaller than 5 hectares, limiting both ecological connectivity and coordinated management. This spatial fragmentation is compounded by ownership fragmentation, with 53% of forests nationally under private ownership. These structural realities create institutional bottlenecks that prevent wholesale application of forest management policies, requiring coordination mechanisms—such as forest owner cooperatives and enhanced extension services—to engage thousands of small private landowners in landscape-scale enhancement efforts.

Third, forest enhancement generates substantial co-benefits extending beyond carbon sequestration to include enhanced climate resilience, biodiversity recovery, and ecosystem service provision. Structurally complex, mixed-species forests recover from disturbance more rapidly than simplified systems, provide critical habitat for declining species, and maintain carbon stocks through disturbance events. These co-benefits strengthen the economic and ecological case for ambitious forest enhancement programs, as the true value of reforestation extends far beyond the carbon metric alone.

Forward-looking pathways require three complementary strategies: prioritize management intensity reduction; expand close-to-nature management as the primary operational model; and implement targeted afforestation on abandoned agricultural land, livestock feed grassland, and marginal cropland with explicit corridor objectives while strictly avoiding conversion of endangered grassland ecosystems such as calcareous grasslands and other species-rich grasslands.

Success depends fundamentally on political commitment to sustained coordination and financial investment in technical capacity building. The pathway forward is operationally clear and biophysically feasible—Belgium possesses sufficient suitable land to achieve even the ambitious S3 scenario without compromising highly productive agricultural areas or endangered ecosystems. The critical variable remains whether Belgium's federal governance structure can generate sufficient coordination to translate forest enhancement potential into on-the-ground implementation across the 25-year timeframes required for meaningful landscape transformation.

5 PART 4 – ADDITIONAL ANALYSIS ON WETLANDS AND PEATLANDS

Wetlands play a vital role in both climate change mitigation and adaptation. They contribute to climate mitigation by capturing and storing substantial amounts of carbon, and to climate adaptation through their capacity to regulate floods and buffer against water scarcity. However, the definition and scope of “wetlands” varies across contexts and policy frameworks, which can complicate comparison and data harmonization. The Intergovernmental Panel on Climate Change (IPCC) adopts a land use and land cover-based definition. It defines wetlands as *“areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into the Forest Land, Cropland, Grassland, or Settlements categories.”* This classification includes reservoirs as a managed sub-category, and natural rivers and lakes as unmanaged sub-categories. This definition excludes wetlands that are already classified under other land use categories, making it a relatively narrow and restrictive interpretation (International Panel on Climate Change, 2019). In contrast, the EU Nature Restoration Regulation adopts a more habitat-based approach, aligned with the EU Habitat Directive. It groups habitat types into six categories, one of which is wetland habitats. This category includes a broad range of land types, such as coastal habitats (e.g., estuaries) and peatlands, but also wet heathlands (European Union, 2024). One of the oldest definitions of wetlands is the Ramsar Convention on Wetlands (1971): "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters". This is a broad definition, including wet meadows, wet heaths and riparian forest.

Given these differences, the present analysis follows the IPCC definition of wetlands, as applied in greenhouse gas inventories and the LULUCF context (see also §Part 1: Land use scenarios), while acknowledging that the studies and datasets reviewed often rely on broader ecological or habitat-based interpretations. Efforts were made to clarify and relate these varying definitions to facilitate comparability across data sources.

At the European level, efforts are ongoing within the CLC+ Core framework from the Copernicus Land Monitoring Service to spatially monitor the LULUCF categories (Copernicus Land Monitoring Service, 2021). However, currently, no official, area-wide map of the LULUCF categories is available in Belgium. The first part of the additional wetlands analysis therefore reviews available datasets to assess the extent of wetlands in Belgium, examining both the availability of relevant data and their definitional framework.

Wetlands and peatlands require targeted management approaches. Although their overall surface area may be limited, disturbance or drainage of these ecosystems can lead to disproportionately high greenhouse gas emissions. Conversely, peatland restoration offers substantial carbon storage potential (Lettens, et al., 2014). The second part of this chapter therefore examines the role of wetlands as carbon sinks, identifying restoration measures that are potentially relevant and feasible within the Belgian context.

Finally, the third section provides a preliminary estimate of greenhouse gas emissions from wetlands and peatlands under the various land use change scenarios presented in Part 1. This includes the application of calculation methodologies from the 2006 IPCC Guidelines and the 2013 Wetlands Supplement, as well as an assessment of potential data sources for estimating soil organic carbon stocks in wetland and peatland ecosystems.

5.1 Wetland and peatland extent in Belgium

The 2006 IPCC Guidelines distinguish three subcategories of wetlands: managed peatlands (peat extraction sites), flooded lands (including reservoirs, canals, ponds, and ditches), and other wetlands (IPCC, 2006). The Belgian National Inventory Report (NIR) categorizes all wetlands as 'Other Wetlands', as there are no peat extraction sites in Belgium and no distinction can be made with flooded land. The NIR reports that Belgium has approximately 57 000 ha of wetlands, which includes open water bodies. According to the NIR, wetlands are mostly located in the 'Fagnes' region in the Belgian Ardennes. This area is designated as a Natura 2000 site and has been the focus of extensive restoration efforts. A major LIFE project was implemented between 2007 and 2012 to rehabilitate degraded peatlands and wet heaths in the region (European Commission, 2025) (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).
The NIR also reports N_2O and CO_2 emissions on cultivated organic soils, which only occurs in Flanders and has been estimated based on an intersection of the CORINE Land Cover dataset from 1990 and the Belgian soil map. The area is assumed constant over the entire time series and totals 2520 ha of agricultural area, of which 1899 ha cropland and 621 ha grassland. In Wallonia, 7957 ha of organic soils are reported, which are mostly situated in forest land and wetland areas (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

5.1.1 Wetland extent

5.1.1.1 Regional: Flanders

Decleer et al. (2016) conducted a spatial analysis of wetland loss and restoration potential in Flanders based on existing datasets such as the Belgian soil map and the Biological Valuation Map (*Biologische Waarderingskaart;* (Instituut Natuur- en Bosonderzoek, 2023)). The study defines wetlands in terms of habitat types, following the European Habitats Directive. This includes floodplain meadows and forests, moist to wet heathlands, and woodlands on peaty or swampy soils. According to the IPCC land use classification, however, these habitats are not considered wetlands, as they fall under grassland or forest categories. Decleer et al. (2016) estimated that approx. **68 000 ha** of such wetlands remain in Flanders – a decline of about 75% compared to the 1950s. This loss is primarily attributed to urbanization and agricultural intensification, with a smaller contribution from increased forestry activities. The most affected habitats include moist to wet heathlands, nutrient-poor grasslands and forests, and wet floodplain ecosystems (Decleer, et al., 2016).

The **Nature Restoration Regulation** references the EU Habitats Directive to define 'wetlands' as one of six habitat categories, encompassing various habitat types such as bogs, fens, estuaries, and wet heathlands and excluding open water (European Union, 2024) (Council of the European Communities, 1992). In Flanders, the Biological Valuation Map provides area-wide coverage of terrestrial ecosystems, including those relevant to the EU Habitats Directive, and assesses their corresponding biological value. It is compiled using field surveys, aerial imagery, and expert interpretation. Based on the Biological Valuation Map, approx. **12 600 ha** in Flanders fall within the 'wetlands' habitat category.

5.1.1.2 Regional: Wallonia

As part of the Belgian contribution to **LifeWatch**-ERIC, the European Research Infrastructure Consortium dedicated to biodiversity and ecosystem research, a high-resolution (2 m) land cover map series has been developed for the Walloon region, covering the years 2006, 2010, 2015, 2018, and 2022. In addition, a Belgian-wide land cover map was produced for the year 2015. These datasets integrate remote sensing data, including orthophotos and Sentinel-1 and Sentinel-2 imagery, with ancillary thematic information such as crop type inventories, road networks, and forest classifications. The maps distinguish 13 land cover classes, including the class 'Inundated grassland and scrub of biological interest'. According to the 2022 dataset, this class covers approx. **3750 ha** in Wallonia, while the 2015 Belgian dataset estimates this category at around **6200 ha** (UCLouvain, Geomatics Unit, 2023) (Radoux, et al., 2023).

5.1.1.3 European datasets

At the European level several datasets exist that depict 'wetlands' according to differing definitions. The **extended wetland layer**, with a resolution of 100 m, can be considered a spatial representation of wetlands in line with the definition established by the Ramsar Convention on Wetlands (1971). This definition includes "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*." It also explicitly considers certain managed, agricultural landscapes, such as grazed or managed wet meadows and pastures, as wetlands (Ramsar Convention Secretariat, 2016). Based on this broad classification, the extended wetland layers identify approximately **77 400 ha** of wetland area in Belgium, of which around 54 000 ha are located in Flanders and 23 400 ha in Wallonia. Excluding open water, the extended wetland layer covers a total of approx. **59 700 ha** of wetlands in Belgium (European Environment Agency, 2023).

The **Dynamic Land Cover (DLC) product** (resolution of 100 m) of the Copernicus Land Monitoring Service includes the category of herbaceous wetlands, defined as: "*Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present in either salt, brackish, or fresh water".* The DLC (2019) depicts a total of approx. **5900 ha** of herbaceous wetlands in Belgium, of which 4900 ha in Flanders. Permanent water bodies cover a total of **12 600 ha** in Belgium (Copernicus Land Monitoring Service, 2024).

ALFAwetlands (Advancing Landscape-scale Functional Assessment of Wetlands) is a Horizon Europe research project that seeks to improve geospatial knowledge of wetlands across Europe, assess restoration pathways through collaborative co-creation processes, and develop sustainability indicators aimed at maximizing the benefits of wetland restoration for climate change mitigation, biodiversity, and other ecosystem services (ALFAwetlands, 2024). As part of the project, an EU-wide wetland map was produced, with a projected resolution of 30 m, identifying approximately 390 100 ha of wetlands in Belgium – of which 247 800 ha are located in Flanders, 140 900 ha in Wallonia, and 1400 ha in Brussels. This European wetland map was constructed based on European datasets regarding the riparian and coastal zones, complemented with local datasets, such as the Belgian soil map. The wetland map also includes floodplains, both actual and potential. When these floodplains are excluded, a total of **212 900 ha** remain, comprising 126 600 ha in Flanders, 86 200 ha in Wallonia, and 100 ha in Brussels. Resp. 67 400 ha and 37 300 ha of peatland are mapped according to the ALFAwetlands map in Flanders and Wallonia, resulting in a total of approx. 106 700 ha of peatland in Belgium (Tegetmeyer, et al., 2025). The relatively high wetland area identified by ALFAwetlands reflects its broad methodological scope, which includes not only existing wetlands but also potential wetland, regardless of current land use. This approach, oriented toward restoration potential, explains why the dataset may stand out as an outlier compared to the other geospatial datasets.

The Copernicus Land Monitoring Service and European Environment Agency are currently developing a European **Corine Land Cover (CLC)+ LULUCF instance**. This dataset is produced with a resolution of 100 m and is based on the EAGLE data model and utilizes European Copernicus data. The 2021 CLC+ LULUCF instance, available upon request, has a spatial resolution of 100 meters. The Belgian CLC+ LULUCF instance depicts **35 800 ha wetlands**, of which 23 900 ha are situated in Flanders and 11 900 ha in Wallonia. A further distinction is made between the subcategories 'Wetlands', totaling approx. 9300 ha, and 'Water', amounting to 26 500 ha in Belgium.

Table 60: Overview of spatial datasets mapping a 'wetland' category, the corresponding 'wetland' definition and the extent of wetland and open water on the maps in Belgium.

	Data source	**Geographical Extent**	**Resolution**	**Scope – Wetland definition**	**Wetland area (ha)**	**Open water area (ha)**	**Total area (Wetland and open water) (ha)**
Belgium	NIR	Belgium	200 ha	IPCC-definition	/	/	57 000
	LifeWatch (Belgium)	Belgium (2015)	2 m x 2 m	'Inundated grassland and scrub of biological interest'	6200	38 300	44 500
Regional	LifeWatch (Wallonia)	Wallonia (2022)	2 m x 2 m	'Inundated grassland and scrub of biological interest'	3800	12 200	16 000
	Decleer et al. (2016)	Flanders	20 m x 20 m	Open water, Wetlands (open and forested) on meso-eutrophic and oligotrophic, permanently wet and temporary wet soils	49 900	18 100	68 000
	BWK – Nature Restoration Regulation	Flanders	Vectorial dataset	Nature Restoration Regulation – bogs, fens, estuaries, and wet heathlands	12 600	/	12 600
European	Extended Wetland Layer	Europe	100 m x 100 m	Ramsar Convention on Wetlands – 'Riparian forest', 'Managed or grazed wet meadow or pasture', 'Wet heaths', 'Inland marshes', 'Beaches, dunes, sand', …	59 700	17 700	77 400
	ALFAwetlands	Europe	30 m x 30 m	Floodplains (actual, potential and maximum extent) , Coastal wetlands, Other wetlands, Peatland	390 100	/	390 100
	Dynamic Land Cover	Europe	100 m	'Herbaceous wetland'	5900	12 600	18 500
	CLC+ LULUCF instance	Europe	100 m	IPCC-definition	9300	26 500	35 800

5.1.2 Peatland extent

The **soil map of Belgium** was developed based on an intensive soil survey conducted between the 1950s and 1970s. This nationwide campaign involved high-density soil profile sampling. In addition, approximately 100 000 representative soil profile pits were excavated to a depth of 2 meters for systematic description and sampling. The resulting soil map is based on the Belgian soil classification system, a national framework specifically designed for the specific characteristics of Belgian soils. In this classification, peat is defined by its organic matter content: soils containing more than 30% organic material are classified as peat, provided the continuous peat layer is at least 30 cm thick. The category "peat admixture" refers to organic-rich layers with less than 30% organic matter, for which no minimum thickness is required (Van Ranst & Sys, 2000) (Swinnen, et al., 2023).

Based on the presence of peat in the soil profile – identified through the texture, substrate and the variant of the parent material – a total of approximately 27 500 ha of peat soils are identified in Flanders (Databank Ondergrond Vlaanderen, 2025) and around 16 000 ha in Wallonia (Service public de Wallonie (SPW), 2022). This results in a combined total of roughly **43 500 ha of peat soils across Belgium**. Considering only peaty soil texture results in 23 000 ha in Belgium, 15 000 ha in Flanders and 8000 ha in Wallonia.

In Flanders, a study was conducted to obtain more detailed information on the spatial distribution of peat. This analysis resulted in the development of **peat probability maps**, which estimate the likelihood of peat presence at various depths. These maps were developed based on a combination of data sources, including the Belgian Soil Map, the Biological Valuation Map, geological information, and additional in situ observations. Drawing on both recent and historical data, the study estimated the likelihood of peat occurrence at different depths: at the surface, within the soil profile up to 1.5 meters, and in the deeper subsoil between 1.5 and 10 meters (Swinnen, et al., 2023). Based on the 5 x 5 meter resolution peat probability map for surface peat, a total of approx. **50 000 ha** of land in Flanders is estimated to have peat occurring at the surface, while approx. 101 500 ha of land in Flanders probably has peat within the soil profile (up to 1.5 m) (Databank Ondergrond Vlaanderen, 2025). Around 44 400 ha is estimated to contain peat both at the surface and in the soil profile. Although the peat probability maps provide an estimate of the occurrence of peat, similar to the Belgian soil map, it should also be noted that the maps have not yet been systematically validated, which adds to the uncertainty regarding their accuracy and limits their immediate applicability for policy-making.

Table 61: Overview of extent of peat soils based on the soil map of Belgium (Databank Ondergrond Vlaanderen, 2025) (Service public de Wallonie (SPW), 2022) and the peat probability maps in Flanders (Swinnen, et al., 2023).

Data Source	Definition	Extent in Belgium (ha)	Extent in Wallonia (ha)	Extent in Flanders (ha)
Soil map of Belgium	Presence of peat in the soil profile (texture, substrate and the variant of the parent material)	43 500	16 000	27 500
Soil map of Belgium	Peaty soil texture	23 000	8000	15 000
Peat probability map	Surface peat	/	/	50 000
Peat probability map	Peat in soil profile	/	/	101 500

5.2 Wetland and peatland restoration

Wetlands, and particularly peatlands, play a complex and dual role in greenhouse gas (GHG) dynamics. Due to their high carbon density, natural peatlands act as a long-term carbon sink. However, when peatlands are drained or degraded, they transition from sinks to sources of GHG emissions, primarily through the oxidation of organic peat material. This process is triggered by increased aeration of the soil following drainage, which facilitates microbial decomposition and results in the release of carbon dioxide (CO_2), and to a lesser extent, nitrous oxide (N_2O). Conversely, under saturated (anaerobic) conditions, such as in undisturbed or rewetted wetlands, oxygen availability is limited, which slows organic matter decomposition and supports carbon sequestration. Lowering the average groundwater table in peatlands leads to an increase in emissions: Jurasinski et al. (2016) found that a peatland with an average groundwater table depth of 40 cm below the surface induces emissions of around 20 t CO_2eq/ha/year (Jurasinski, et al., 2016). Increasing the average water table reduces emissions, with every 0.5 m increase leading to a reduction in emissions of roughly 20 t CO_2eq (Figure 37) (ETC-CA, 2022).

However, rewetting, while reducing CO_2 emissions, also leads to a resurgence of methane (CH_4) emissions due to anaerobic microbial processes. This is also reflected in Figure 37 and Figure 38, which show an increase in GHG emissions after submergence of peatlands (ETC-CA, 2022) (Leifeld & Torrús Castillo, 2025). The radiative effects and atmospheric lifetimes of CO_2 and CH_4 differ, with CO_2 being a weak but persistent GHG, while CH_4 is a strong but short-lived greenhouse gas. Taking this into account, recent studies have demonstrated that the climate mitigation benefits of reduced CO_2 emissions outweigh the warming effect of CH_4, particularly over longer time horizons. As such, rewetting peatlands is considered essential for restoring their function as long-term carbon sinks and for achieving climate neutrality objectives (Günther, et al., 2020) (Lettens, et al., 2014) (Mander, et al., 2024). However, it is important to control water levels in peatland to reduce fluctuations of the water table (ETC-CA, 2022).

In addition to their strategic importance for climate mitigation, wetlands and peatlands are also key biodiversity hotspots, supporting a wide range of specialized and often threatened species. Recognizing their dual value for both climate and biodiversity, the EU Nature

Restoration Regulation places emphasis on the restoration and rewetting of wetland habitat types, but also of drained peatlands, which extend beyond strictly defined wetland habitats. The regulation sets targets for the restoration of drained peatlands under agricultural use, mandating restoration on at least 30% of such areas by 2030 (with at least a quarter rewetted), 40% by 2040 (with at least one-third rewetted), and 50% by 2050 (again with at least one-third rewetted) (European Union, 2024).

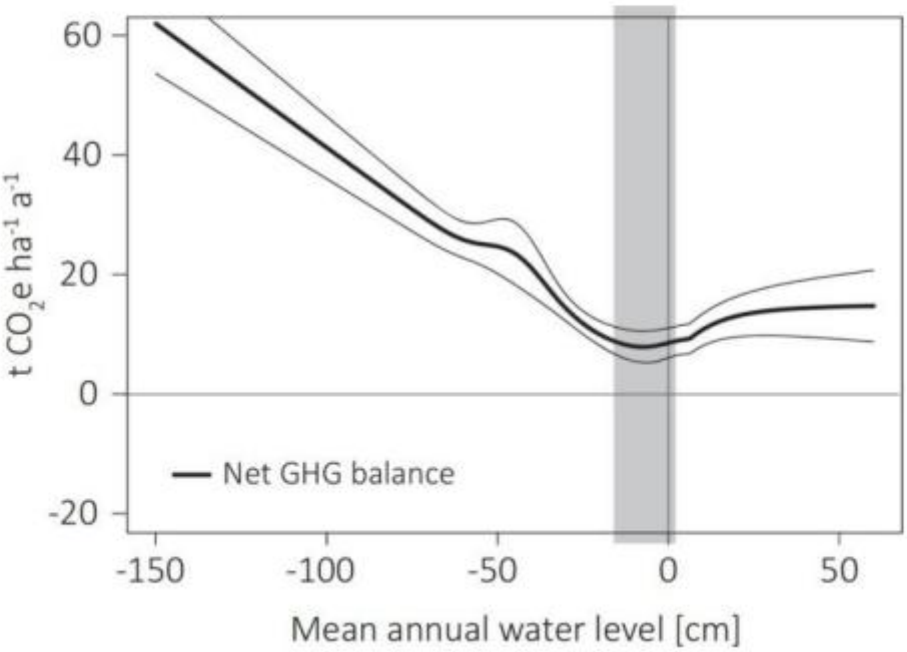


Figure 37: Relationship between emissions of CO_2 equivalents and mean annual water level in peatlands. The increase in emissions when peatland is submerged, can be attributed to an increase in methane emissions (Reproduced from (ETC-CA, 2022), originally from (Jurasinski, et al., 2016)).

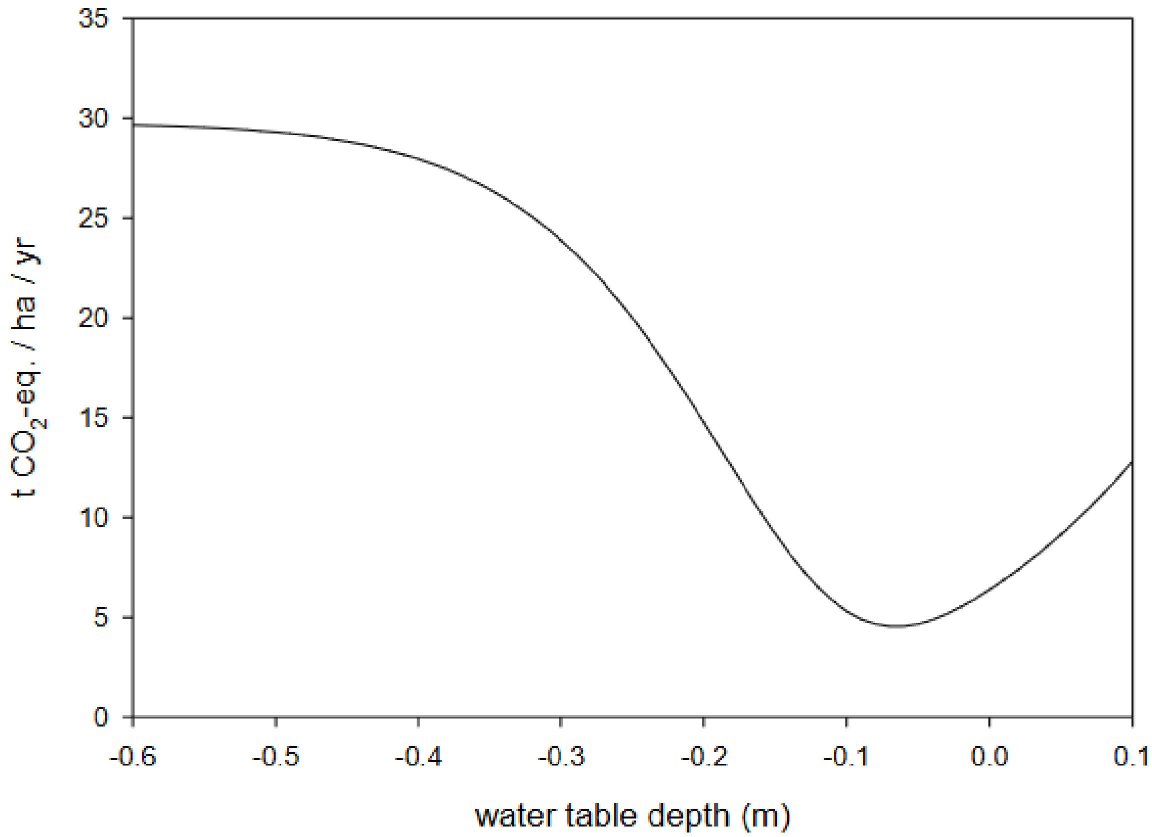


Figure 38: Relationship between the CO_2 balance (Net Ecosystem Productivity) and the water table depth (m) considering fluxes of CH_4 and CO_2. (Reproduced from (Leifeld & Torrús Castillo, 2025)).

Several European initiatives, outlined below, are underway in Belgium to restore wetlands and peatlands, aiming to enhance carbon sequestration, biodiversity, and water management. Key management practices employed in these restoration efforts include the removal or blocking of drainage ditches, re-leveling and naturalizing creeks to restore hydrological conditions, and the removal of trees and shrubs to prevent encroachment. Additionally, mowing is used as a management tool to control nutrient levels and prevent dominance by aggressive plant species, helping to maintain diverse wetland vegetation. These measures support rewetting and habitat recovery, contributing significantly to both local ecosystem resilience and broader climate mitigation goals aligned with EU restoration policies.

ALFAwetlands is a Horizon Europe project (2022 – 2026), which encompasses nine Living Labs with 33 wetland sites across Europe, fostering collaboration on ecological, economic, and social issues. Through these Living Labs the project aims to enhance restoration practices that can be scaled to other areas. Three of these Living Labs are situated in Belgium, specifically in Flanders (ALFAwetlands, 2024):

- **Dijle valley**: In this floodplain, restoration is pursued through 'non-intervention' approach, whereby natural processes are allowed to proceed without interference, causing the river channel roughness to increase. This facilitates more frequent bankfull discharge events, promoting natural flooding dynamics and ecological recovery.
- **Zuidleie valley**: Historically, fen meadows and transition mires fed by mineral-rich groundwater have been degraded due to land abandonment, drainage, and sludge deposition. Adjacent infiltration zones are affected by intensive agriculture,

groundwater extraction, and increased soil sealing. Climate change exacerbates these issues through both more frequent extreme droughts and high water table events. Restoration interventions include mowing management – reintroduced after more than 30 years of abandonment and nutrient-rich flooding –, and sludge removal combined with mowing (restarted in 1992). Long-term monitoring evaluates the sustainability of restoration efforts and investigates how hydrological conditions and management practices can be optimized to improve climate change resilience in fen and mire ecosystems.

- **Zwarte Beek valley**: This site, featuring 2 to 8 meter peat deposits, is being restored to preserve its substantial carbon stocks. Restoration measures include rewetting through ditch removal and tree clearance. Comparative assessments of greenhouse gas fluxes and carbon stocks across intact, rewetted, and drained systems aim to provide the first estimates of avoided greenhouse gas emissions and long-term carbon sequestration potential associated with floodplain rewetting.

The **LIFE Programme** serves as the European Union's primary funding instrument for environmental and climate-related initiatives. Anderson et al. (2017) reviewed peatland restoration efforts supported by the LIFE Nature programme, noting that between 1993 and 2015, a total of €167.6 million was invested in 80 projects aimed at restoring over 913 km² of peatland habitats across Western Europe. These projects primarily focused on protected Natura 2000 sites, and collectively addressed less than 2% of the region's remaining peatland area, much of which has been affected by anthropogenic disturbance. Common restoration measures included tree removal and the blocking of ditches and drains to re-establish natural hydrology. In Belgium, three initial LIFE Nature projects launched between 1995 and 1998 targeted the conservation of rich fens, transition mires, and remnant bog woodlands. Between 1998 and 2015, six additional projects have aimed to restore extensive areas of raised bogs, acidic fens, and associated woodland habitats. Restoration activities have been implemented over approx. 5400 hectares of degraded peatlands, and included techniques such as water table restoration through ditch blocking, surface re-leveling by removing the peat surface or vegetation and subsoil scraping, and rewetting bogs with peat, clay or PVC dams. Additional measures such as tree and shrub removal, mulching, and targeted grazing were employed to peatland vegetation recovery (Andersen, et al., 2017).

The **LIFE Multi Peat project**, funded under the LIFE Climate Change Mitigation Programme, aims at restoring degraded peatlands across five countries – Belgium, Germany, Ireland, the Netherlands and Poland –, to mitigate climate change and enhance biodiversity. In Belgium, restoration efforts are focused in the valley of the Grote Beek in Flanders, where 130 ha of peatland will be restored. The project aims to restore the area's natural hydrology by damming and relevelling canals and ditches to raise the water table to between 10 and 20 cm below the surface. In addition, a paludiculture pilot site will be established, and greenhouse gas emissions will be monitored to quantify emissions and uptake of greenhouse gases (LIFE Multi Peat, 2023). Soil organic carbon stock was estimated using measurements taken in 50 cm depth intervals, yielding a total peat volume of approximately 1.07 million m³. Assuming a bulk density of 0.32 g/cm³ and a carbon fraction of 34.8%, the total carbon stored in this peat layer was calculated at -119 028 t C or approx. 436 kt CO2eq (LIFE Multi Peat, 2023) (LIFE Multi Peat, 2024). To provide an initial estimate of GHG emissions from the drained peatlands at the project site, the Greenhouse Gas Emission Site Types (GEST) methodology was applied. This approach links average annual water levels to GHG emissions, using the presence or absence of specific vegetation types as indicators of site conditions such as moisture levels, nutrient status, and acidity. The GEST method requires detailed vegetation mapping to divide the area into uniform units, each assigned specific emission factors (Jarašius, et al., 2022). Based on this methodology the drained project site in the Grote Beek valley is estimated to emit yearly 14.4 t CO_2eq/ha, amounting to an annual total of 1755 t CO_2eq/yr (LIFE Multi Peat, 2023).

Care-Peat is an Interreg North-West Europe (NWE) project running from 2019 to 2023, involving 12 partners collaborating to reduce carbon emissions and restore the carbon storage capacity of different types of peatlands across North-West Europe. The project includes 7 pilot sites, one of which is the valley of the Zwarte Beek in Flanders. At this site, rewetting measures included the closing of internal ditches – the impact of which was initially assessed using sand bags –, and reducing the frequency of creek clearance, resulting in a higher water level in the creeks and the surrounding peatland. Some of the creeks were also relevelled. To prevent dominance by certain plant species, mowing was carried out using equipment adjusted to the wet soil conditions to avoid compaction, and grazing was discontinued on the wettest areas for the same reason.
A key component of Care-Peat was the development of a numerical model to predict carbon fluxes at the peatland-atmosphere interface, which is challenging due to site specific conditions. This model was integrated in a Decision Support Tool (DST), designed to optimize site restoration and management. Using inputs such as water table depth, temperature, solar radiation and vegetation type, the tool predicts the GHG fluxes and determines whether a peatland site behaves as a carbon sink or not. In Flanders, GHG emissions were also monitored during restoration, with initial measurements indicating a reduction in carbon emissions of approx. 15 t CO_2/ha/yr. The DST estimated a similar reduction of about 19 t CO_2/ha/yr corresponding to a water table rise of around 30 cm. These field measurements and model predictions together confirm the beneficial impact of rewetting peatlands on carbon emissions (Mestdagh, et al., 2023).

5.3 Emissions from wetlands and peatlands

5.3.1 IPCC guidelines

5.3.1.1 IPCC 2006 guidelines: current calculations in NIR

In Belgium's National Inventory Report (NIR), greenhouse gas emissions from wetland areas are primarily reported in relation to changes in soil organic carbon (SOC) stocks due to land use changes. The change in SOC stocks is considered over a period of 20 years. During this period a specific carbon stock change related to the land use converted into wetland is applied. After 20 years, the land that was converted, will be considered 'Wetland remaining wetland'. For wetlands remaining wetlands, no emissions are reported, as there is currently no available data on SOC stock changes over time, and these stocks are thus assumed to remain stable. As mentioned in §5.1, no distinction is made within the land use category 'Wetlands' – all wetlands are categorized as 'Other Wetlands' –, and no distinction is made between, for instance, fen peatlands or open water. A provisional default value of **100 t C/ha** (based on pers. comm. Prof. Bas Van Wesemael, 2007) is used to estimate the SOC stock in the 0–30 cm soil layer of wetlands and peatlands due to a lack of refined classifications (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). The default Tier 1 value for soil organic carbon stock in the upper 30 cm in wetland soils in warm temperate regions is 88 t C/ha (IPCC, 2006).

For the emissions of cultivated organic soils – only reported in Flanders –, the NIR includes CO_2 and N_2O emissions based on default 2006 IPCC guidelines Tier 1 emission factors. For CO_2 yearly values of **2.5 t C/ha** and **10 t C/ha** are implemented for resp. grassland and cropland. The N_2O emissions are calculated based on the default emission factor of 8 kg N_2O-N/ha (IPCC, 2006). Although drained and degraded wetlands and peatlands may also emit

CH_4, as discussed in the previous section, these emissions are often omitted in national inventories (ETC-CA, 2022). In Belgium, CH_4 emissions from wetlands are currently not included in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

The Global Warming Potential (GWP) from AR5 with a cumulative forcing over 100 years is used to convert emissions from CH_4 and N_2O to CO_2eq. The GWP is assumed 28 for CH_4 and 265 for N_2O (IPCC, 2014).

5.3.1.2 IPCC Wetlands Supplement (2013)

The IPCC Wetlands Supplement offers additional and updated guidance to the 2006 IPCC Guidelines, specifically addressing inland organic soils (drained and rewetted), wetlands on mineral soils, coastal wetlands – including mangrove forests, tidal marshes, and seagrass meadows –, and constructed wetlands used for wastewater treatment. The implementation of the Wetlands Supplement is not limited to the land use category of wetlands: the lands covered in the Wetlands Supplement may occur in any of the land use categories, for instance for cultivated organic soils (IPCC, 2014). Below three methods (drained and rewetted inland organic soils, and inland wetland mineral soils) are briefly summarized. These methods will be applied to wetlands in Belgium to assess the impact of land use changes on carbon sinks and emissions in the different scenarios (see also §5.3.2).

5.3.1.2.1 Drained inland organic soils

For drained inland organic soils the Wetlands supplement provides guidance to estimate emissions from CO_2, CH_4 and N_2O. The calculation method to estimate **CO_2** emissions or removals from drained organic soils is defined as:

$$CO_2, C_{organic,drained} = CO_2, C_{on-site} + CO_2, C_{DOC} + L_{fire}, CO_2, C \quad (1)$$

With CO_2-$C_{on-site}$ [tonnes C/yr] as on-site C emissions/removals by drained organic soils, CO_2-C_{DOC} [tonnes C/yr] as CO_2-C emissions from dissolved organic carbon (DOC) exported from drained organic soils, and L_{fire}-CO_2-C [tonnes C/yr] as C emissions from burning of drained organic soils. The emissions from burning of drained organic soils will not be taken into account. CO_2-$C_{on-site}$ is further defined as:

$$CO_2, C_{on-site} = A * EF \quad (2)$$

With A [ha] as land area of drained organic soils and EF [t C/ha/yr] as emission factors for drained organic soils. For drained cropland, the Tier 1 default value is **7.9 t C/ha/yr**. For grassland a distinction is made between nutrient poor grasslands with an emission factor of **5.3 t C/ha/yr**, deep-drained nutrient rich grasslands with an emission factor of **6.1 t C/ha/yr**, and shallow-drained nutrient-rich grasslands with an emission factor of **3.6 t C/ha/yr**.

CO_2-C_{DOC} is defined similarly as CO_2-$C_{on-site}$, but uses a different EF. This emission factor is derived based on the flux of DOC from natural (undrained) organic soils ($DOC_{FLUX\_NATURAL}$; tonnes C/ha/yr), the proportional increase in DOC flux from drained sites relative to undrained sites ($\Delta DOC_{DRAINAGE}$) and a conversion factor for the proportion of DOC converted to CO_2 following export from the site ($Frac_{DOC-CO2}$):

$$EF_{DOC} = DOC_{FLUX_{NATURAL}} * (1 + \Delta DOC_{DRAINAGE}) * FRAC_{DOC-CO_2} \quad (3)$$

For a temperate region the Wetlands Supplement estimates the default Tier 1 value of EF_{DOC} at **0.31 t C/ha/yr**, with the $DOC_{FLUX\_NATURAL}$ of 0.21 t C/ha/yr, the $\Delta DOC_{DRAINAGE}$ of 0.6 and the $Frac_{DOC-CO2}$ set at 0.9.

Methane emissions from drained organic soils ($CH_{4\_organic}$, kg CH_4/yr) are estimated in the Wetlands Supplement as follows:

$$CH_{4_{organic}} = A * \left((1 - Frac_{ditch}) * EF_{CH_{4_{land}}} + Frac_{ditch} * EF_{CH_{4_{ditch}}}\right) \quad 4$$

With A [ha] as land area of drained organic soils in a land use category, EF_{CH4_land} [kg CH_4 /ha/yr] as emission factor for direct CH_4 emissions from drained organic soils, EF_{CH4_ditch} [kg CH_4 /ha/yr] as the emission factor for CH_4 emissions from drainage ditches, $Frac_{ditch}$ as the fraction of total area of drained organic soil which is occupied by ditches, ditches being considered by any area of manmade channel cut into the peatland. For each of the emission factors Following Tier 1 default values are provided in the Wetlands Supplement for temperate regions:

- For EF_{CH4_land}:
  - Cropland: **0 kg CH_4/ha/yr**
  - Grassland:
    - Drained, nutrient-poor: **1.8 kg CH_4/ha/yr**
    - Deep-drained, nutrient-rich: **16 kg CH_4/ha/yr**
    - Shallow-drained, nutrient-rich: **39 kg CH_4/ha/yr**
- For EF_{CH4_ditch}:
  - Shallow-drained grassland: **527 kg CH_4/ha/yr** with a $Frac_{ditch}$ of 0.05
  - Deep-drained grassland and cropland: **1165 kg CH_4/ha/yr** with a $Frac_{ditch}$ of 0.05

Annual direct **N_2O** emissions from drained/managed organic soils (N_2O-N_{OS}, kg N_2O-N/yr) are estimated based on the annual area of drained/managed organic soils (F_{OS}, ha) and the emission factor for N_2O emissions from drained/managed organic soils (EF_2, kg N_2O-N/ha/yr):

$$N_2O, N_{OS} = F_{OS} * EF_2 \quad 5$$

Updated values for the emission factor EF_2 are provided in the Wetland Supplement for drained cropland and grassland, which were estimated at 8 kg N_2O-N/ha/yr for cropland and grassland as implemented in the Belgian NIR following the 2006 IPCC guidelines. The updated value is increased to **13 kg N_2O-N/ha/yr** for drained cropland. For grassland, a distinction is made between nutrient poor grasslands with an EF_2 of **4.3 kg N_2O-N/ha/yr**, deep-drained nutrient rich grasslands with an EF_2 of **8.2 kg N_2O-N/ha/yr**, and shallow-drained nutrient-rich grasslands of **1.6 kg N_2O-N/ha/yr**.

5.3.1.2.2 Rewetted inland organic soils

The Wetlands Supplement provides estimates of CO_2 and CH_4 emissions after rewetting organic soils:

$$\Delta C_{rewetted\ org\ soil} = CO_2, C_{rewetted\ org\ soil} + CH_4, C_{rewetted\ org\ soil} \quad 6$$

With $\Delta C_{rewetted\ org\ soil}$ [t C/yr] as net carbon gain or loss after rewetting organic soil, CO_2,C [t C/yr] as the net flux of CO_2-C after rewetting, and CH_4,C [t C/yr] as the net flux of CH_4-C after rewetting.

CO_2-C emissions [t C/yr] after rewetting are estimated as follows:

$$CO_2, C_{rewetted\ org\ soil} = CO_2, C_{composite} + CO_2, C_{DOC} + L_{fire}, CO_2, C \quad 7$$

With CO_2,$C_{composite}$ [t C/yr] as CO_2-C emissions/removals from the soil and non-tree vegetation, CO_2,C_{DOC} [t C/yr] as the emissions from dissolved organic carbon exported from rewetted organic soils, and L_{Fire},CO_2,C [t C/yr] as the CO_2-C emissions from burning of rewetted organic soils. The emissions from burning of rewetted organic soils will not be further taken into account.

The CO_2-$C_{composite}$ from rewetted organic soils is estimated according to the area rewetted (A [ha]) and an emission factor EF_{CO2} [t C/ha/yr]:

$$CO_2, C_{composite} = A * EF_{CO2} \quad (8)$$

For temperate regions, a distinction is made between emission factors for nutrient poor (**-0.23 t CO_2-C/ha/yr**) and nutrient rich (**0.5 t CO_2-C /ha/yr**) conditions.

The emissions from dissolved organic carbon from rewetted organic soils is similarly derived from the rewetted area (A [ha]) and an emission factor $EF_{DOC\_rewetted}$ [t C/ha/yr], which is **0.24 t CO_2-C/ha/yr**.

Methane emissions from rewetted organic soils (CH_4-$C_{rewetted\ org\ soil}$, t C/yr) are also calculated based on the rewetted area (A [ha]) and an emission factor $EF_{CH4,soil}$ [kg CH_4-C/ha/yr]. The emissions of CH_4-C from burning of rewetted organic soils ($L_{fire,}CH_4$,C) is not taken into consideration here:

$$CH_4, C_{rewetted\ org\ soil} = CH_4, C_{soil} + L_{fire}, CH_4, C \quad (9)$$

$$CH_4, C_{soil} = \frac{\sum A * EF_{CH4,soil}}{1000} \quad (10)$$

The emission factor $EF_{CH4,soil}$ is defined according to climate zone and nutrient status, with **92 kg CH_4-C/ha/yr** for nutrient poor sites and **216 kg CH_4-C/ha/yr** for nutrient rich sites in temperate regions.

N_2O emissions from rewetted organic soils are assumed to be negligible under Tier 1 in the Wetland Supplement.

5.3.1.2.3 Inland Wetland Mineral Soils

The chapter on Inland Wetland on Mineral Soils of the Wetland Supplements contains updated values for soil organic carbon stocks SOC_{ref} provided in table 2.3 in the 2006 IPCC Guidelines (in Chapter 2). These values are updated for temperate, warm climate zones from **88 t C/ha** in the 2006 IPCC Guidelines to **135 t C/ha**.
Additionally, the chapter provides an emission factor $EF_{CH4\text{-}IWMS}$ [kg CH_4/ha/yr] to estimate CH_4 emissions after rewetting of drained inland wetland mineral soils and CH_4 emissions from created wetlands on managed lands with mineral soils:

$$CH_{4-IWMS}\left[kg\frac{CH_4}{yr}\right] = \sum A * EF_{CH4-IWMS} \quad (11)$$

For temperate regions the emission factor $EF_{CH4\text{-}IWMS}$ is estimated at **235 kg CH_4/ha/yr**.

5.3.2 Methodology to estimate emissions from wetlands and peatlands

Measurements regarding GHG emissions from wetlands in Belgium are generally limited in scope and are insufficient to establish reliable national estimates. Because of the absence of consistent and long-term measurement data, greenhouse gas emissions from wetlands in Belgium are estimated following the IPCC guidelines and the default Tier 1 emission factors provided in these guidelines. For drained organic soils, all agricultural land on these soils is assumed to be drained, given the lack of detailed information on the extent and implementation of drainage systems. For rewetted wetlands, the IPCC guidelines do not specify a fixed duration for applying emission factors for CH_4 and N_2O emissions. For this study, these emission factors are applied over a 20-year transition period, following the 20-

year land use change assumption, representing the time it takes for the ecosystem to reach a new steady state, after which the site is considered 'wetlands remaining wetlands.'

5.3.2.1 Current (2022)

The current carbon stock in wetlands is estimated based on the emissions and removals reported in the NIR. The provisional value of 100 t C/ha used in the NIR is applied to estimate SOC stocks in wetlands. This value is higher than the Tier 1 default of 88 t C/ha from the 2006 IPCC Guidelines but lower than the Tier 1 value of 135 t C/ha proposed in the Wetlands Supplement for inland wetland mineral soils. Preliminary CMON data suggest a value of 91.6 t C/ha for wetlands. Peatlands, however, are known to have significantly higher SOC stocks. For example, Swinnen et al. report a peatland SOC stock of approx. 247 t C/ha in the upper 30 cm (Swinnen, et al., 2020) (Swinnen, et al., 2023). Despite the likelihood of underestimating peatland SOC by assuming 100 t C/ha, no differentiation between open water, peatlands and mineral wetlands is currently made across the 57 000 ha of wetlands. Therefore, the provisional value of 100 t C/ha is retained for estimation purposes.

The NIR submission of 2024 reports in 2022 a total of approx. 53 520 ha in the category 'Wetlands remaining wetlands', and 3330 ha 'Lands converted to Wetlands'. The land conversion results in a net emission of -4.33 kt CO_2eq. The SOC stock is assumed stable in wetlands (remaining wetlands) and, with a provisional value of 100 t C/ha, thus amounts to 5352 kt C or a total soil carbon stock of 19 624 kt CO_2eq, with a conversion factor of 44/12 to convert tonnes C into tonnes CO_2eq (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

To assess the emissions from cultivated organic soils, the areas in the land use change scenarios are implemented: 10 000 ha of grassland and 6000 ha of cropland. These areas are assumed to be drained, and yearly on-site carbon, DOC, nitrous oxide and methane emissions from are estimated based on the methods and default Tier 1 values described in the Wetlands Supplement for drained inland organic soils. Emission factors for drained cropland and deep-drained nutrient rich grasslands are implemented. For on-site carbon emissions, the emission factors are thus resp. 7.9 t C/ha/yr and 6.1 t C/ha/yr for cropland and grassland. An emission factor of 0.31 t C/ha/yr is implemented to estimate emissions from DOC. In the Wetland Supplement, emission factors for N_2O-N for drained inland organic soils are updated to 13 kg N_2O-N/ha/yr for drained cropland and 8.2 kg N_2O-N/ha/yr for deep-drained nutrient rich grasslands. Methane emissions are estimated based on the Tier 1 default values, implementing an EF of 0 kg CH_4/ha/yr for cropland and 16 kg CH_4/ha/yr for deep-drained, nutrient-rich grasslands, with the assumption of a $Frac_{ditch}$ of 0.05 with an EF of 1165 kg CH_4/ha/yr. This results in emissions of 397.5 kt CO_2eq/yr for on-site carbon emissions, of 18.2 kt CO_2eq/yr for DOC, 66.6 kt CO_2eq/yr from N_2O, and 30.4 CO_2eq/yr from methane emissions. In conclusion, drained agricultural land emits **512.6 kt CO_2eq/yr** (222.9 kt CO_2eq/yr from 6000 ha cropland and 289.7 kt CO_2eq/yr from 10 000 ha grassland).

5.3.2.2 Reference and current policy scenario 2050

Land use changes in the wetland category are assumed negligible in both the reference and policy land use change scenarios. Therefore, by 2050 around 57 000 ha wetlands are assumed to have a SOC content of 100 t C/ha.

Yearly emissions from drained organic peatlands are assumed to remain the same as the current yearly emissions, i.e. following the methodology of the Wetlands Supplement emissions of 222.9 kt CO_2eq/yr from drained cropland and 289.7 kt CO_2eq/yr from drained grassland is assumed.

5.3.2.3 Major land use change scenario 2050

In the major change scenario 10 000 ha of grassland and 23 000 ha of flood prone settlement areas are converted into wetlands. These land use changes are assumed to be allocated linearly, i.e. with an average yearly allocation of approx. 385 ha of grassland and 885 ha settlement area to wetland to reach a total of 33 000 ha of additional wetlands by 2050 (Figure 39). This linear allocation is checked and corrected following the requirements of the Nature Restoration Regulation, stipulating that at least 30% of drained agricultural peatlands need to be restored by 2030, leading to a slightly higher allocation of grassland to wetlands between 2025 and 2030.

The soil organic carbon stock in grassland and settlement area is taken from the NIR and assumed to be 74 t C/ha in Flanders and 90 t C/ha in Wallonia for grasslands, and 54 t C/ha in Flanders and 51 t C/ha in Wallonia for settlement area. As mentioned before, the soil organic carbon stock for wetlands is assumed to be 100 t C/ha. As grassland or settlement area is converted to wetlands, the soil organic carbon stock sequestration will thus increase with resp. -0.5 and -2.45 t C/ha/yr for converted grassland and settlement area in Wallonia and resp. -1.3 and -2.3 t C/ha/yr for converted grassland and settlement area in Flanders.

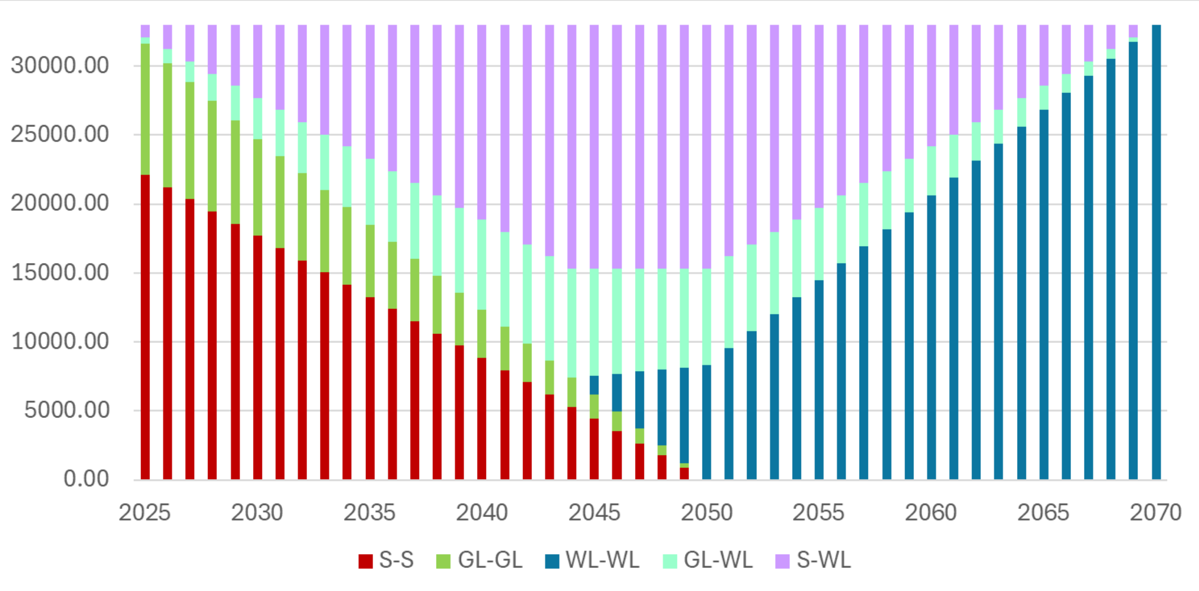


Figure 39: illustration of land use changes between 2025 and 2070 of grassland (GL) and settlement area (S) to wetlands (WL). On average, approx. 385 ha of grassland and 885 ha settlement area are yearly converted to wetland. These areas are considered as land use changes (GL to WL and S to WL) for 20 years, building SOC stocks. After 20 years, these areas are considered wetlands (WL-WL) with a stable organic content of 100 t C/ha.

Grassland on organic soils converted to wetlands can also emit GHG, as described in the Wetlands Supplement for Rewetted inland organic soils. This methodology is used to calculate emissions from Dissolved Organic Carbon (DOC) (0.24 t C/ha/yr) and methane (92 kg CH_4-C/ha/yr) to estimate emissions from the converted grasslands on peatland, assuming nutrient poor conditions. No additional EF (-0.23 t CO_2-C/ha/yr for nutrient poor conditions) is implemented for on-site carbon removals, as these removals are assumed to be covered by the increase in SOC described above.

The methane emissions from 'Inland Wetlands Mineral Soils' are calculated for the settlement area converted into wetland area. This area is assumed not to be peatland. An EF of **235 kg CH_4/ha/yr** is implemented to estimate these emissions.

The major change scenario also assumes a conversion of 6000 ha of drained cropland on peatland to shallow-drained grasslands. The emissions from rewetting these areas are estimated based on the methodology described in the Wetland Supplement for drained inland organic soils (§5.3.1.2.1), with emission factors for shallow-drained, nutrient rich grassland: on-site carbon emissions are estimated by 3.6 t C/ha/yr, methane emissions are estimated with an emission factor of 39 kg CH_4/ha/yr, N_2O emissions are calculated based on an emission factor of 1.6 kg N_2O/ha/yr.

Table 62: An overview of the applied methodologies and emission factors (EF) used to estimate carbon emissions, both on-site and as dissolved organic carbon (DOC), nitrous oxide (N_2O) emissions and methane (CH_4) emissions. Methodologies were implemented from the National Inventory Report (NIR), following the IPCC 2006 Guidelines, providing a carbon stock of 100 t C/ha for wetlands (WL). Emissions and removals from conversion from grassland (GL) and settlement area (SA) to wetlands are estimated based on the methodologies described in the IPCC Wetland Supplement (WS).

		Area	Methodology	Carbon stock (t C/ha)	C on-site (t C/ha/yr)	EF DOC (t C/ha/yr)	EF N_2O (N_2O-N/ha/yr)	EF CH_4 (kg CH_4/ha/yr)
Current (2022)	WL remaining WL	57 000 ha	NIR	100	/	/	/	/
	Cultivated organic soils	10 000 ha GL 6000 ha CL	WS – drained inland organic soils	/	7.9 (CL), 6.1 (GL)	0.31	13 (CL), 8.2 (GL)	0 (CL), 16 (GL)
Reference (2050)	WL remaining WL	57 000 ha	NIR	100	/	/	/	/
	Cultivated organic soils	10 000 ha GL 6000 ha CL	WS – drained inland organic soils	/	7.9 (CL), 6.1 (GL)	0.31	13 (CL), 8.2 (GL)	0 (CL), 16 (GL)
Current policy (2050)	WL remaining WL	57 000 ha	NIR	100	/	/	/	/
	Cultivated organic soils	10 000 ha GL 6000 ha CL	WS – drained inland organic soils	/	7.9 (CL), 6.1 (GL)	0.31	13 (CL), 8.2 (GL)	0 (CL), 16 (GL)
Major Change (2050)	WL remaining WL	57 000 ha	NIR	100	/	/	/	/
	GL to WL	10 000 ha	WS – rewetted inland organic soils	74 (Flanders), 90 (Wallonia)	-1.3 (Flanders), -0.5 (Wallonia)	0.24	0	92
	SA to WL	23 000 ha	WS – inland wetland mineral soils	54 (Flanders), 51 (Wallonia)	-2.3 (Flanders), -2.45 (Wallonia)	/	/	235

5.3.3 Results

5.3.3.1 Reference and current policy scenario 2050

As mentioned in §5.3.2.1, the methodology of the NIR is implemented to estimate the current carbon stock in wetlands. The NIR of 2024 reports in 2022 53 520 ha in the category 'Wetlands remaining wetlands', and 3330 ha 'Lands converted to Wetlands'. The land conversion results in a net removal of -4.33 kt CO_2eq. Assuming a stable SOC stock of 100 t C/ha, the carbon stock in 'Wetlands remaining wetlands' amounts to 5352 kt C, or a total stock of 19 624 kt CO_2eq (conversion factor of 44/12 to convert tonnes C into tonnes CO_2eq) (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). In both the reference and current policy scenarios, the wetland area is assumed stable. By 2050, all wetlands (57 000 ha) are thus assumed to be in the category of 'Wetlands remaining wetlands', with a total, stable carbon stock of 20 900 kt CO_2eq.

Emissions from cultivated organic soils are estimated for 10 000 ha of grassland and 6000 ha of cropland. Using Tier1 default values of the Wetland Supplement, drained agricultural land emits 512.6 kt CO_2eq/yr (222.9 kt CO_2eq/yr from cropland and 289.7 kt CO_2eq/yr from grassland). Between 2025 – 2050 these emissions from cultivated organic soils would amount to a total of **12 815.8 kt CO_2eq,** 5572.2 kt CO_2eq from 6000 ha of drained cropland and 7243.7 kt CO_2eq from 10 000 ha of drained grassland.

5.3.3.2 Major land use change scenario 2050

As described in §5.3.2.3, wetland conversion in the major land use change scenario are assumed to be allocated linearly, i.e. with an average yearly allocation of approx. 385 ha of grassland and 885 ha settlement area to wetland to reach a total of 33 000 ha of additional wetlands by 2050 (Figure 39). As drained grassland on peaty soils or settlement area with a high risk of flooding is converted to wetlands, the soil organic carbon stock will increase with resp. -0.5 and -2.45 t C/ha/yr for converted grassland and settlement area in Wallonia and resp. -1.3 and -2.3 t C/ha/yr for converted grassland and settlement area in Flanders. This increase in stock is considered over a period of 20 years.

Figure 40 depicts the additional, cumulative sequestration in SOC stock (in kt CO_2eq) from 2025 to 2050 from gradually converting grassland and settlement area in wetlands. By 2050 the conversion of grassland and settlement area to wetlands leads to a total sequestration of **-3090.6 kt CO_2eq** between 2025 and 2050. After 20 years, the converted land will be considered 'Wetland remaining wetland', with a stable soil organic carbon stock. By 2050 approx. 5300 ha settlement area and 3000 ha grassland will be considered 'wetland remaining wetland', leading to an additional carbon stock of **-3046.2 kt CO_2eq** in the 'wetland remaining wetland' category in 2050. A total SOC stock of approx. **23 900 kt CO_2eq** in 2050 is thus estimated in 65 300 ha wetlands remaining wetlands.

As wetland conversion is implemented gradually between 2025 and 2050, and carbon stock changes are considered over a period of 20 years, the full carbon sequestration from converting 10 000 ha grassland and 23 000 ha settlement area will only be reached by 2070, 20 years after the last conversion to wetlands. The total carbon sequestration between 2025 and 2070 amounts to **-4825.3 kt CO_2eq**. The total carbon stock in wetlands would then amount to **33 000 kt CO_2eq.**

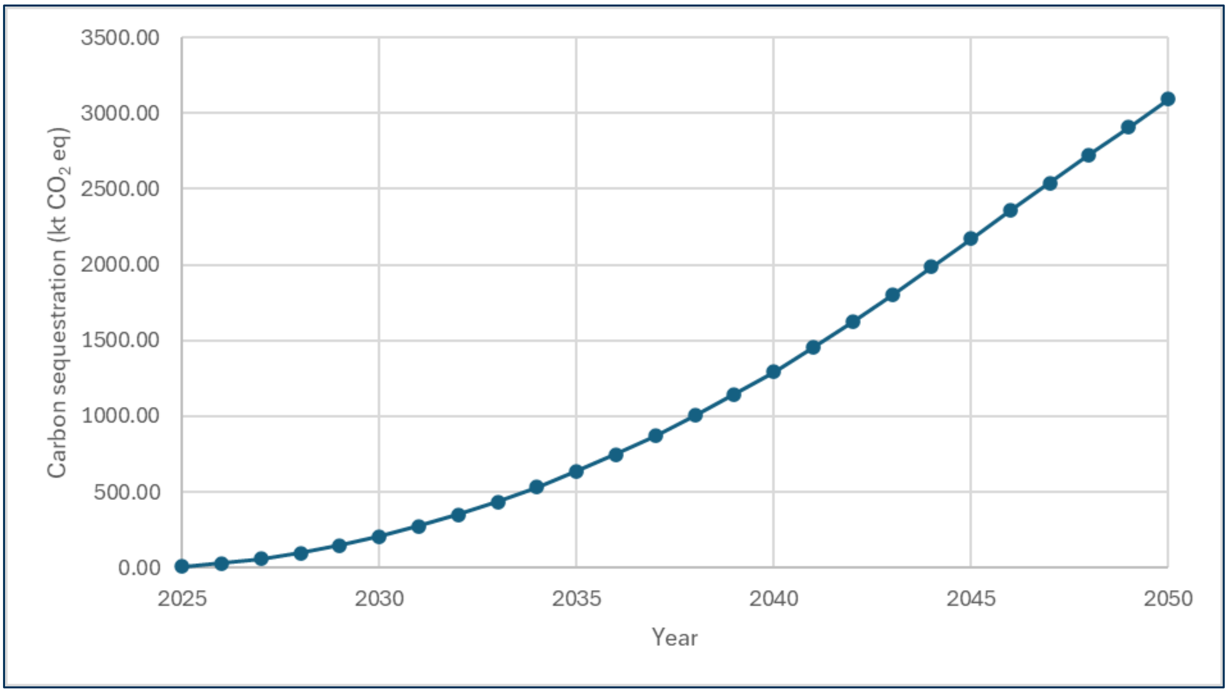


Figure 40: Evolution of cumulative carbon sequestration (kt CO_2eq) between 2025 and 2050 as a result of the conversion of 10 000 ha grassland and 23 000 ha settlement to wetlands. The conversion is assumed to be implemented gradually over the full time period.

As mentioned above (§5.2, §5.3.1.2.1 and §5.3.1.2.2), peatlands can also emit GHG, even after rewetting. The emissions from Dissolved Organic Carbon (DOC) and methane are estimated for the 10 000 ha of grassland to be converted to wetlands. By 2050, emissions from DOC total 117.5 kt CO_2eq and methane emissions amount to a total of 458.5 kt CO_2eq. Consequently, rewetting 10 000 ha of drained agricultural grassland would lead to a total emission of **576 kt CO_2eq** between 2025 and 2050. For the settlement area converted into wetland, the methane emissions from 'Inland Wetlands Mineral Soils' are calculated. This settlement area is assumed not to be peatland. Methane emissions from conversion of settlement area lead to an additional emission of **1920.9 kt CO_2eq** between 2025 and 2050.

The major change scenario also assumes a conversion of 6000 ha of drained cropland on peatland to shallow-drained grasslands. The conversion of cropland to shallow-drained grassland on peatland is estimated following the 'drained inland organic soils' methodology. This conversion results in a yearly emission of 100.7 kt CO_2eq/yr or a total emission of **2516.7 kt CO_2eq** between 2025 and 2050. In the reference/current policy scenario, the total emission of drained cropland on peatlands by 2050 was estimated at 5572.2 kt CO_2eq. As such, converting drained cropland to shallow-drained grassland leads to a reduction in emissions of 3055.5 kt CO_2eq.

Table 63 provides an overview of the SOC stock, sequestration and emissions from the wetland areas in the current situation, and in the three land use change scenarios. In the major change scenario, the conversion of grassland and settlement area to wetlands leads to a carbon sequestration of approx. -3090.6 kt CO_2eq between 2025 and 2050. The emissions from these wetlands in this time period are estimated at 2496.9 kt CO_2eq, which means that an increase and restoration of wetland areas would lead to a net sink of **-593.8 kt CO_2eq** by 2050. Figure 41 provides a time series of emissions from the land use conversion into wetlands.

Table 63: Overview of SOC stock, emissions and removals from wetland area in the situation, and according to the three land use change scenarios by 2050. The current situation is represented by the latest year (2022) of the NIR submission of december 2024 (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

	Current	Reference (2050)	Policy (2050)	Major Change (2050)	Major Change (2070)
Wetlands remaining wetlands (ha)	53 500	57 000	57 000	65 300	90 000
Land converted to wetlands (ha)	3300	/	/	24 700	/
Stock (Wetlands remaining wetlands) (kt CO_2eq)	19 624	20 900	20 900	23 900	33 000
Removals (Land converted to wetlands) (2025 - …) (kt CO_2eq)	-4.3	/	/	-3090.6	-4825.3
Emissions (Land converted to wetlands) (2025 – …) (kt CO_2eq)		/	/	2496.9	3889.7
Net emissions (2025 – …) (kt CO_2eq)		/	/	-593.8	-935.5
Emissions drained agricultural land (2025 – …) (kt CO_2eq)		12 815.8	12 815.8	2516.7	5033.4

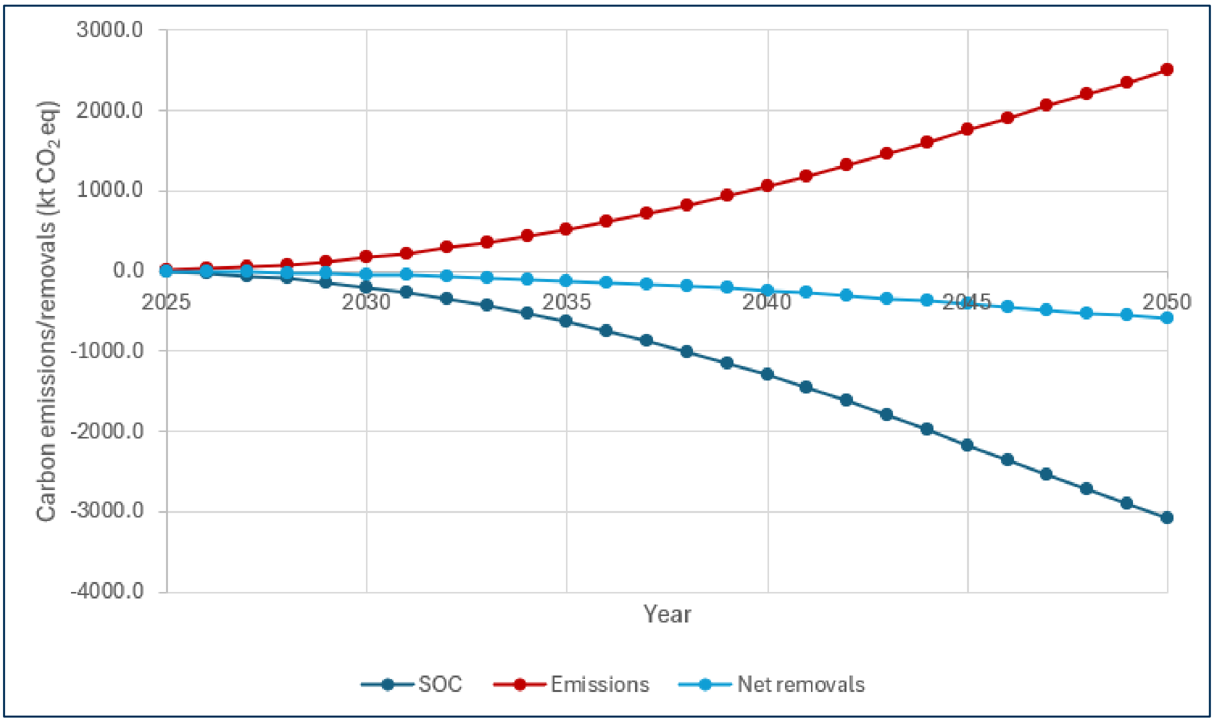


Figure 41: Estimated GHG sequestration, emissions and net removals from 2025 to 2050 from the conversion of 10 000 ha grassland and 23 000 ha settlement area to wetlands.

5.4 Discussion and conclusion

According to the conservative estimate provided here, following the methodology provided by the IPCC in the wetlands supplement using Tier 1 default values, the conversion of 10 000 ha grassland and 23 000 ha of settlement area in the major land use change scenario would lead to a net sequestration of -593.9 kt CO_2eq by 2050. By 2030 the net removal of these land conversions to wetland would contribute a total of -37.8 kt CO_2eq to the Belgian target of -320 kt CO_2eq as set in the LULUCF regulation (European Parliament and the Council of the European Union, 2018). Beyond their carbon sequestration potential, wetlands also hold substantial soil organic carbon stocks. These stocks, however, are vulnerable to drainage and droughts, which can accelerate oxidation and transform wetlands from carbon sinks into sources. Protecting and restoring wetlands, especially peatlands, is therefore essential to prevent carbon losses (Leifeld & Torrús Castillo, 2025).

The estimates of GHG emissions and removals were derived from IPCC Tier 1 default values. Soil monitoring can provide more accurate, region-specific emission factors. In both Flanders and Wallonia, networks exist to monitor soil carbon fractions, but these are mainly focused on cropland, grassland, and forest soils.

In 2021, Flanders launched the soil carbon monitoring network **CMON** with the goal of tracking organic carbon stocks in soils across five main land use categories: cropland (including temporary grassland), permanent grassland, forest, nature, and settlement area (artificial land use). Settlement area is further subdivided into four subcategories: gardens, parks and recreational areas, roadside verges, and other sealed or developed surfaces. Over a 10-year period, soil samples will be collected from 2594 plots distributed across these land use categories (Departement Omgeving, 2024). In the long term, insights from the CMON network are expected to contribute to the quantification of soil carbon stocks within the LULUCF-framework in Flanders. The CMON network will thus enable the systematic assessment of soil organic carbon content and its changes over time, offering insight into carbon loss and storage in Flemish soils. Data from the third monitoring year (625 plots sampled of the 2694 plots) of the first 10-year monitoring cycle are available. Although wetlands are not defined as a separate land use category within the CMON framework, they were recorded as field observations and may fall under several land use categories. In the 26 sampled plots identified as wetland, the average soil organic carbon (SOC) stock was 98.6 t C/ha in the 0–30 cm layer (standard deviation = 46.8; minimum = 31.2; maximum = 221.3), and 231 t C/ha in the 0–100 cm layer (standard deviation = 197; minimum = 42.8; maximum = 768.0). These figures also highlight the importance of carbon storage in deeper soil layers in wet soils. When grassland and forest plots are excluded, only two plots can be classified as strictly wetland. Their SOC stocks were 119.3 t/ha and 63.9 t/ha, respectively, with an average of 91.6 t C/ha (Oorts, et al., 2024). This is slightly lower than the current LULUCF estimate for wetlands implemented in the Belgian NIR, which is 100 t C/ha (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).
CARBIOSOL is a research initiative in Wallonia, Belgium, aimed at integrating biological indicators and soil carbon fractions for cropland and grassland soils into CARBOSOL, a monitoring network of soil organic carbon stocks and dynamics in Wallonia. The project was carried out by researchers from the University of Liège and the Université Catholique de Louvain, with support from the Public Service of Wallonia (SPW). It combines soil sampling, laboratory analysis, and modelling to estimate SOC content and its potential evolution under different agricultural practices (Quentin, et al., 2019).

The provisional value of 100 t C/ha is used to estimate SOC stock in the upper 30 cm of soil in wetlands. No distinction is made within wetlands, therefore no distinction is made between, for instance, fen peatlands or open water (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). However, soil measurements indicate that peatlands store substantially higher amounts of SOC. Swinnen et al. (2020) measured soil organic carbon content in four river floodplains, including the catchment of the Zwarte Beek. These measurements were also used in the establishment of the peat probability map of Flanders (Swinnen, et al., 2023), and estimate the average bulk density of peatlands at 0.3 g/cm³ with a soil organic carbon content of 27.45%, which results in a peatland SOC stock of 247.05 t C/ha in the upper 30 cm (Swinnen, et al., 2020) (Swinnen, et al., 2023). Li et al. (2024) modelled peat thickness and soil carbon storage in the top 1 m soil in the area of the Hautes Fagnes based on high-resolution UAV remote sensing. Both thickness and carbon storage show great spatial variability. The SOC carbon stock in the top 1 m soil was found ranging between -176.13 and -856.57 t C/ha (Li, et al., 2024). A more consistent mapping of wetlands, peatlands and their land use across Belgium would allow a clearer distinction within wetland categories and thereby refine estimates of carbon content for different wetland types.

In addition to SOC stock, wetlands and peatlands also exhibit spatial and temporal variability in GHG fluxes, particularly for methane (CH_4) and nitrous oxide (N_2O), depending on factors such as hydrology, vegetation type, and management practices (Jarašius, et al., 2022). Currently, data on GHG fluxes from Belgian wetlands are scarce and are typically collected within the framework of individual research or restoration projects, such as Multi Peat or Care-Peat, rather than through a systematic or long-term observation network. There is no coordinated monitoring network in place at the regional or national level. Moving towards such a network would be necessary to develop region-specific emission factors and to progress toward Tier 2 or Tier 3 reporting under IPCC guidelines.

The emission estimates based on IPCC Tier 1 default values point to the importance of wetland restoration for climate mitigation, even though these estimates remain uncertain. The importance of wetland restoration is further supported by recent projects such as MULTI-Peat and Care-Peat, which demonstrate the significant role of peatland and wetland restoration in reducing GHG emissions, and restoring and protecting carbon sinks, while delivering co-benefits for biodiversity. While restoring wetlands and peatlands, it is important to take into consideration the nutrient status and water levels in peatlands, as nutrient rich conditions or fluctuating water levels can increase GHG emissions. Restoring hydrological conditions, for instance by removing drainage ditches, and appropriate mowing management to reduce nutrient status are thus essential practices in wetland restoration.

6 PART 5 - CONSOLIDATION AND CONCLUSION

The European LULUCF Regulation supports climate change mitigation by reinforcing carbon sinks, in line with the EU's commitment to achieve climate neutrality by 2050. It sets binding national targets for all Member States, requiring Belgium to secure an additional -320 kt CO_2eq in carbon storage by 2030 (European Parliament and the Council of the European Union, 2023). Meeting this intermediate target would necessitate reversing the current declining trend of the LULUCF sink (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Previous analyses of pathways toward a low-carbon Belgium show that reaching deep emission reductions by 2050 is technically possible but highly ambitious, with overall emission reductions ranging from 93% to 96% compared to 1990 (FPS Public Health, DG Environment, Climate Change Section, 2021). As such, these long-term pathways imply that achieving climate neutrality requires a significant strengthening of the LULUCF sink, substantially higher than the current contribution of about 0.4% of current yearly GHG emissions in Belgium (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). In this context, this study assessed the potential of natural carbon sinks in Belgium, focusing on both land use change scenarios and land management practices. Three scenarios were considered and compared to an estimate of the current situation: a reference scenario, a scenario reflecting current policies and a major land use change scenario.

The implications of the three scenarios have been assessed in specific analyses on the land use sectors of agriculture, forest and wetlands. A summary of the estimated emissions and removals in each sector is provided in Table 64. Drawing on the sector-specific analyses, the following paragraphs highlight the key outcomes in each scenario, showing how policy measures and more ambitious land-use transformations can influence natural carbon sinks, and where the greatest opportunities lie to enhance Belgium's carbon sinks.

In addition to emissions and removals within agricultural land, forests and wetlands, conversion to settlement area was also included in Table 64. Emissions associated with settlement expansion were estimated analogue to the methodology proposed in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). More information on the calculation of these estimates can be found in Annex 6.

6.1.1 Reference scenario

The **reference scenario** reflects a continuation of current land-use trends. The area of cropland and forest remain approximately stable. The share of settlement area increases by about 4 percentage points, from 23% to 27% of the total area, largely at the expense of grassland, whose area share also decreases by about 4 percentage points (from 20% to 16%) (Figure 4). Such developments may negatively affect carbon sinks, as grasslands, especially new established ones, can provide an important sink (Verma, et al., 2025). Though the sequestration potential of long established grasslands declines, these grasslands can still function as an important carbon stock (Lockwood, et al., 2025).

Agricultural land-management practices evolve only modestly, with biodiversity areas remaining stable and a limited uptake of agroforestry (2.5% of cropland and 7.5% of grassland) and organic farming (4% in Flanders, 19% in Wallonia). Those evolutions lead to an increase in land-use removals from agriculture: agroforestry and biodiversity areas increases the sink from -49 kt CO_2eq/yr in the current situation to -344 kt CO_2eq/yr in the reference scenario. However, the removals cannot compensate for the land-based emissions from cropland and drained agricultural land, leading to a net land-based emission of 776 kt CO_2eq/yr. Without agroforestry the land-based sink in agriculture remains approximately the same as in the current situation, at 1071 kt CO_2eq/yr.

Forests remain the largest carbon sink in the reference scenario, with yearly net emissions between -1700 and -2270 kt CO_2eq/yr, which represents an increase of approximately 7% compared to the current situation. In the reference scenario, deforestation and afforestation are at an equilibrium. The increase in sink indicates that the establishment of juvenile forests, with a higher sequestration rate, temporarily compensates for the deforestation, which creates a carbon surplus between 2025 and 2050. Wetlands remain stable in the reference scenario, assuming no emissions or removals.

Under the reference scenario, continued settlement expansion, including the conversion of approximately 10 kha of forest, 42 kha of cropland and 70 kha of grassland, leads to estimated emissions of about 437 kt CO_2eq/yr.

In the reference scenario the land-based sink, consisting of agricultural land, forests, wetlands and settlement area, totals between -487 and -1057 kt CO_2eq/yr, which is slightly higher than current level and the equivalent of **0.3% to 0.7% of 1990 emissions** (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). However, reaching this potential in the reference scenario entails the moderate uptake of agroforestry. Without this moderate uptake of agroforestry, the land-based sink declines from between -487 to -1057 kt CO_2eq/yr to between -192 to -762 kt CO_2eq/yr. Moreover, without changes in management practices, this sink remains vulnerable to climate-related risks such as drought, fire, and pest outbreaks, which may compromise long-term sequestration potential.

An estimate was also provided for emissions in the agricultural sector. The evolutions in agricultural practices and the decreasing trend in the bovine meat and pork sector in the reference scenario also lead to a reduction in agricultural emissions with 22% compared to the current situation. Despite the reduction in emissions in the agricultural sector, the overall land-based sink is not sufficient to compensate for agricultural emissions in the reference scenario.

6.1.2 Current policy scenario

The **current policy scenario** integrates the effects of current policies with an impact on land use and land use changes. Several regional policy frameworks in Belgium aim to counteract some of the existing land use change trends with the aim to enhance carbon sequestration, as outlined in the *Plan Air Climat Énergie (PACE) 2030* for Wallonia (Gouvernement Wallon, 2023) and the *Vlaams Energie- en Klimaatplan* (Vlaamse Regering, 2023). Both regions emphasize the preservation of existing grasslands and the gradual cessation of urban expansion to achieve zero net land take. In Flanders, policies additionally support afforestation, whereas in Wallonia, where forest cover is already comparatively high, efforts focus on improving the resilience of existing forests. The resulting land-use changes are relatively minor compared to the current situation, with the share of grassland in the total area remaining largely stable (-1 percentage point, from 20% to 19%) and the share of settlement area showing a similarly modest increase (+1 percentage point, from 23% to 24%) (Figure 6). This highlights that current policies are essential not only to reverse trends leading to decreasing carbon sinks, but even to maintain current levels of carbon sinks. Besides, a moderate uptake of agroforestry (5% on cropland and 15% on grassland) and organic farming (16.5% in Flanders, 57% in Wallonia) is assumed, while pig production is assumed to decrease more than in the reference scenario.

Moderate agroforestry and biodiversity areas uptake increases agricultural removals from -344 kt CO_2eq/yr in the reference scenario to approx. -695 kt CO_2eq/yr. Due to limited conversion of grassland into cropland, the cropland-related emissions from agriculture decrease with approx. 34% compared to the reference scenario, to 541 kt CO_2eq/yr. However, as emissions from drained organic soils remain the same as in the reference scenario (513 kt CO_2eq/yr), agricultural land remains a net source of emissions of approx. 163 kt CO_2eq/yr. Compared to the reference scenario and the current situation, the current policy scenario leads to a reduction in the net land-based emissions of agriculture by resp. 79% and 85%. However, agricultural land does not become a sink in the current policy scenario.

Afforestation efforts and avoided deforestation, due to reduced land take, strengthen the forest sink in the current policy scenario to a total sequestration between -1930 and -2520 kt CO_2eq/yr. This corresponds to an increase in sink by -230 to -250 kt CO_2eq/yr compared to the reference scenario. Compared to the current situation there is an additional sequestration between -340 and -400 kt CO_2eq/yr in the current policy scenario. This corresponds to an increase in sink of resp. 11% – 13.5% and 18.9% – 21.4% compared to the reference scenario and current situation.

Wetland trends and emissions from drained agricultural organic soils remain identical to the reference scenario.

In the current policy scenario, reduced land take (2 kha forest, 9 kha cropland and 16 kha grassland to settlement area) lowers emissions due to settlements to around 98 kt CO_2eq/yr.

The total land-based sink in agricultural land, forests, wetlands and settlement area in the current policy scenario is estimated at a total of -1669 to -2259 kt CO_2eq/yr, which means an increase to approximately **1.1% – 1.5% of 1990 emissions** (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024), indicating that current policies help stabilize and slightly reinforce carbon sequestration compared to the current situation. Policies aiming to increase climate resilience of carbon sinks help maintain carbon sinks. The uptake of organic farming and agroforestry increases climate adaptation and resilience in the agricultural sector (Aertsens, et al., 2013), while regional forest codes prioritize a diverse mix in species and uneven aged stands (Gouvernement Wallon, 2021).

Due to the higher decrease in pig production and higher uptake of organic farming, agricultural emissions decline by 26% compared with the current situation (i.e., the period 2018-2022), and by 6% relative to the reference scenario. Despite the further decrease in agricultural emissions and increase in the total land-based sink, agricultural emissions are not compensated by the land-based sink.

6.1.3 Major land use change scenario

The **major land use change scenario** was developed based on a literature review and an expert workshop. This scenario was devised to represent a clear departure from historical trends and to go beyond the current level of ambition represented in the current policy frameworks. The scenario proposes a transformative shift in agriculture, including a significant reduction of livestock numbers as a driver of land use change, allowing cropland previously used for livestock feed and forage to be converted into forests and wetlands, while grasslands are preserved. To avoid unintended increases in net imports of animal products, the scenario assumes a parallel dietary shift at the European scale, thereby aligning a lower demand with lower production. As most Belgian meat and dairy production is largely export-oriented and given that most Belgian meat trade occurs within Europe, it is assumed that a European-wide decline in meat consumption would also in equal measure impact exports. Besides livestock reduction, a large-scale uptake of agroforestry (10% on cropland and 30% on grassland) and organic farming (40% in Flanders and 60% in Wallonia) is assumed. Moreover, biodiversity areas on agricultural land are assumed to increase by 10%.

The major land use change scenario represents an ambitious, yet plausible pathway toward enhancing natural carbon sinks and delivering multiple co-benefits for biodiversity, soil health, and ecosystem resilience. It draws on the framework developed in the Agora study on *Climate Neutral Agriculture, Forestry and Food Systems in the EU*, which outlines how land use in agriculture, forestry, and food production can evolve to support climate and environmental goals while maintaining food security and contributing to the bioeconomy (Agora Agriculture, 2024). The scenario assumes an 80% uptake of the Planetary Health Diet, aligning sustainable consumption patterns with reduced land pressure and more space for nature-based solutions (Willett, et al., 2019). Furthermore, it is consistent with several European and regional policy ambitions, including the EU Soil Strategy's target of no net land take by 2050, the European Commission's Vision for Agriculture and Food, the Nature Restoration Regulation and the EU Bioeconomy Strategy. While realizing such a transformation would require deep systemic change and sustained policy commitment, the scenario remains grounded in current scientific knowledge and strategic objectives, making it a demanding but plausible direction for future land use development.

The large-scale uptake of agroforesty and the increase in biodiversity areas increase agricultural removals to -1321 kt CO_2eq/yr. Due to a halt in the conversion of grassland to cropland and a decrease in cropland, land use related emissions in cropland drop significantly to 251 kt CO_2eq/yr. The conversion of drained cropland to shallow-drained grassland leads to a reduction in emissions from drained organic soils from 513 kt CO_2eq/yr to 101 kt CO_2eq/yr. These measures result in a net agricultural land-based emission of -955 kt CO_2eq/yr. The major change scenario is thus the only scenario in which agricultural land becomes a net sink. However, this sink does not compensate for the agricultural emissions of 2817 kt CO_2eq/yr.

Forest expansion drives a substantial increase in the forest sink, reaching yearly emissions of -2480 to -3140 kt CO_2eq/yr. This corresponds to an absolute increase in sinks of approximately 900–1000 kt CO_2eq/yr (approx. +50%) relative to the current situation. Compared with the reference scenario, additional carbon sequestration amount to -490 – -660 kt CO_2eq/yr (approx. 25%), while the increase relative to the current policy scenario is estimated at -440 – -580 kt CO_2eq/yr (approx. 22%).

Wetland restoration generates an average net removal of -24 kt CO_2eq/yr when combining methane emissions and carbon sequestration as a result of rewetting.

In the major land use change scenario, no additional emissions from settlement expansion are estimated, as urban development is assumed to occur exclusively on cropland previously used for feed and forage production, for which mineral soil carbon stocks are equivalent to those of settlement area under the NIR methodology.

Overall, the total land-based sink in agriculture, forests, wetlands and settlement area in the major change scenario rises to between -3459 and -4119 kt CO_2eq/yr, representing **2.4% – 2.8% of 1990 emissions**, making the major change scenario the only scenario that delivers a substantial strengthening of the natural carbon sink.

Due to the reduction in livestock and uptake of organic farming, agricultural emissions fall sharply in the major change scenario: by 56% compared to the 2018-2022 period, and by 44% compared with the reference scenario. As mentioned before, the agricultural land-based sink is not able to compensate for agricultural emissions despite the significant reduction in agricultural emissions. However, due to the significant increase in overall land-based sinks, agricultural emissions can be compensated by the total land-based sinks in the major change scenario. As such, it is the only scenario in which the AFOLU sector (Agriculture, Forestry and Other Land Use) turns into a net carbon sink (-642 – -1302 kt CO_2eq/yr).

6.1.4 General conclusions

Across all scenarios, uncertainty remains a limiting factor. The quantifications presented in this study rely on multiple hypotheses and assumptions, and their robustness is further constrained by data limitations. In this assessment, estimates for wetlands were primarily based on IPCC Tier 1 default values. Agricultural emission factors were mostly derived from the NIR and studies showing the positive impact of agroforestry on carbon sequestration (Aertsens, et al., 2013). Forest estimates also relied mostly on values compiled from literature, with large variance between studies on exact carbon sequestration rates and carbon stocks. As such, exact quantification remains difficult, emission factors will strongly depend on local characteristics, such as soil type, hydrology, vegetation composition, and management practices. It should be noted that LULUCF-related data in the NIR continues to be refined by the regional administrations toward Tier 3 requirements, with ongoing improvements in both land-use classifications and emission factors. As emission factors will strongly depend on local characteristics, it is imperative to implement long-term monitoring networks to refine these estimates. To this end, initiatives such as the soil monitoring network CMON in Flanders (Oorts, et al., 2024) and the CarboStock project in Wallonia (Centre wallon de Recherches agronomiques, 2024) are working to establish comprehensive SOC datasets. Ensuring long-term structural funding will be critical to safeguard the continuity of these initiatives and to build a consistent evidence base for developing regionally appropriate emission factors.

Given these uncertainties, the scenario results should be interpreted primarily as indicative of relative trends and orders of magnitude rather than as precise absolute estimates. They provide insight into the direction and scale of potential changes in carbon sinks under different land-use pathways, rather than definitive predictions of future sequestration levels.

Across all scenarios, agricultural emissions cannot be fully offset by carbon removals on agricultural land alone. Even in the major change scenario, while agricultural emissions decline substantially due to livestock reduction and higher shares of organic farming, and where agroforestry and additional biodiversity areas create a strong agricultural sink, remaining agricultural emissions still exceed agricultural removals by about 1862 kt CO_2eq/yr. Only by combining these efforts with the enhanced forest sinks and wetland restoration in the major change scenario does the AFOLU sector as a whole shift into net carbon removal, reaching negative emissions of -642 to -1302 kt CO_2eq/yr.

Afforestation represents a key lever to strengthen natural carbon sinks in Belgium, with its contribution increasing from the reference scenario to the major land use change scenario. However, the durability of this mitigation potential depends strongly on forest resilience under climate change, as increasing drought stress, pest outbreaks and extreme weather events may undermine carbon storage, particularly in even-aged, monoculture forests. As most clearly reflected in the major change scenario, forest expansion therefore needs to be complemented by adaptive management practices that enhance structural and compositional diversity. Mixed-species stands and diversified forest structures have been shown to improve stability and productivity under climate variability through complementary growth and drought-response mechanisms (Vannoppen, et al., 2020; Vanhellemont, et al., 2019). These measures also generate important co-benefits for biodiversity by increasing habitat diversity and structural complexity (Ampoorter, et al., 2020). Overall, strengthening forest carbon sinks across scenarios requires not only an expansion of forest area, but also qualitative improvements in forest management to ensure resilient and long-lasting carbon storage.

Current land-use policies appear sufficient to stabilize existing carbon sinks and achieve modest improvements. However, only the transformative land-use changes envisaged in the major change scenario result in a pronounced strengthening of natural carbon sinks, driven by large-scale afforestation, extensive uptake of agroforestry systems and wetland restoration. Even under this most ambitious pathway, the overall mitigation impact remains constrained by Belgium's limited land area. Natural carbon sinks reach 2.4% to 2.8% of 1990 national emissions, underscoring that land-based removals, while important, can only make a limited contribution to compensating emissions in other sectors.

In summary, enhancing natural carbon sinks is necessary to achieve EU LULUCF targets and can contribute to ecosystem restoration and resilience. However, with regards to climate change mitigation, it cannot substitute for deep and sustained reductions in greenhouse gas emissions in other sectors. As such, natural sinks form a complementary pillar of climate mitigation: important and worth strengthening but ultimately also constrained by biophysical limits. In addition, continued efforts to improve datasets, monitor carbon stocks and refine methodologies will be indispensable to support effective, transparent and credible land-based climate action in the coming decades.

Table 64: Summary of the results of the estimation of GHG removals and emissions for the current situation and the three land use change scenarios (reference, current policy and major land use change scenario) as presented for agriculture, forests and wetlands. An estimate of emissions from settlements is also provided.

			Current (2025)	Reference (2050)	Policy (2050)	Major change (2050)
Agriculture	*Agricultural Emissions (kt CO_2eq/year)*		*6372*	*4993*	*4706*	*2817*
	LULUC	Emissions cropland (kt CO_2eq/year)	798	827	541	251
		Emissions grassland (kt CO_2eq/year)	-171	-220	-196	14
		Emissions biodiversity (kt CO_2eq/year)	-49	-49	-49	-118
		Emissions agroforestry (kt CO_2eq/year)	0	-295	-646	-1203
		Emissions drained cropland (kt CO_2eq/year)	513	513	513	101
		Total emissions (kt CO_2eq/year)	**1091**	**776**	**163**	**-955**
	Total net agricultural emissions (kt CO_2eq/year)		*7463*	*5769*	*4869*	*1862*
Forests	**Net Emissions (kt CO_2eq/year)**		**-1590 – -2120**	**-1700 – -2270**	**-1930 – -2520**	**-2480 – -3140**
Wetlands	**Net Emissions (kt CO_2eq/year)**		**-4**	**0**	**0**	**-24**
Settlements	**Emissions (kt CO_2eq/year)**		**315**	**437**	**98**	**0**
TOTAL LULUCF emissions from agriculture, forests, wetlands and settlements (kt CO_2eq/year)			**-188 – -718**	**-487 – -1057**	**-1669 – -2259**	**-3459 – -4119**
TOTAL AFOLU (agricultural emissions + LULUCF) emissions (kt CO_2eq/year)			***5654 – 6184***	***3936 – 4506***	***2447 – 3037***	***-1302 – -642***

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ANNEX 1: WORKSHOP MAJOR LAND USE CHANGE SCENARIO – NATURAL CARBON SINKS IN BELGIUM BY 2050 (AND BEYOND)

12/03/2025 – Location: GAL 01.F.1 – Frieden (Brussels)

Present:

- FPS Health: Emily Taylor, Camille Reyniers, Sam Van Hoof, Yegor Tarelkin
- AWAC: Dominique Perrin, Sylviane Thomas
- Departement Omgeving: Guillaume Vandekerckhove
- SPW Agriculture: Silvain Delannoy
- Agentschap Landbouw & Zeevisserij: Victor Vaernewyck
- Organisatie Duurzame Energie: Ellen Van Mello
- VITO: Dieter Cuypers, Karen Gabriels, Lien Poelmans
- Sytra (UCLouvain): Caroline Amrom, Manon Ferdinand
- Agri-Bio Tech (Gembloux – ULiège): Thalès de Haulleville, Fanny Boeraeve, Bernard Heinesch

Excused: Reine Spiessens (WWF), Leen Govaere (ANB), Etienne Hannon (Belgian Climate Center)

Attachment: Powerpoint presentation

Agenda:

- Tour de Table
- Introduction of study – context by Emily Taylor (FOD/SPF)
- Introduction of the study, approach and terminology
- Interactive session (part 1) – open discussion
- Interactive session (part 2) – corners of the room
- Wrap-up

Introduction of the study, approach and terminology

Will the scenarios include EU legislation (e.g. Carbon Removals and Carbon Farming Regulation, Deforestation Regulation, EU Forest Strategy for 2030…)?

The reference scenario will be based on trend extrapolation based on land use change information from the National Inventory Report (NIR). The WEM/WAM scenario is based on regional policies, which should comply with the current EU regulations. The major change scenario is not explicitly based on EU legislation, but can be assessed against EU regulations.

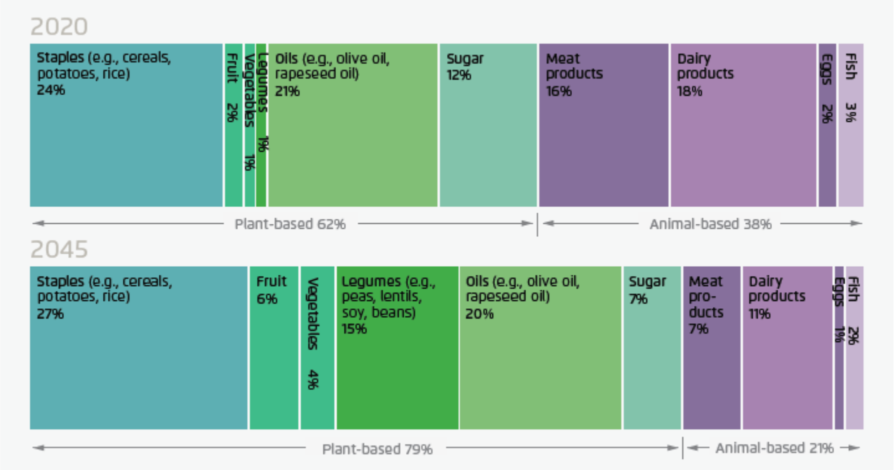
Outline of major land use change scenario – Plenary

The major land use change scenario is based on the comprehensive study of Agora to the agricultural, forest and food sector in a climate neutral EU (Agora Agriculture, 2024). The scenario proposed in this study is translated to the Belgian situation. Below the main remarks of the participants to each of the proposed measures are given.

- **Sustainable food consumption (slide 20)**
    - *Sytra:* BE food consumption (proteins): 60-65% animal-based, 40-35% plant-based. This is also reflected in the study of Agora (see figure below): the calorie share in 2020 is 62% plant-based and 38% animal-based, protein share in 2020 is 30% plant-based and 70% animal-based.

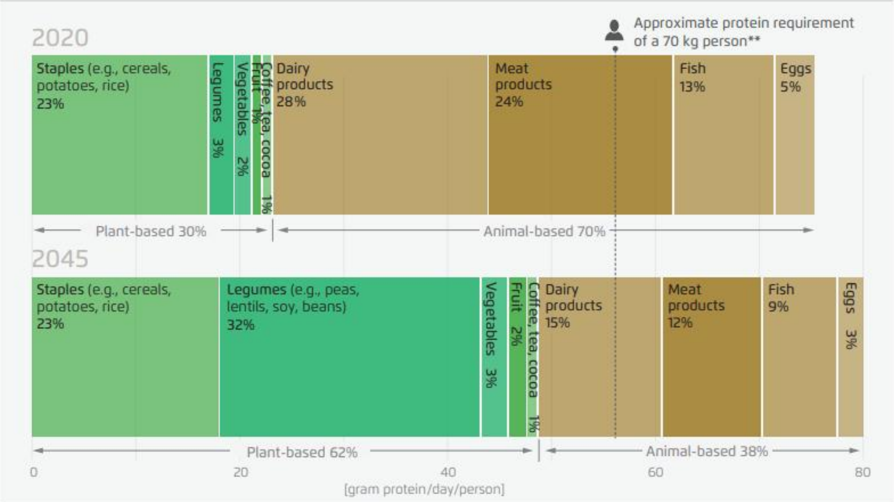
- *Sytra:* Within Belgium there is no problem with food security: with half the arable land, we can feed Belgian population.[9] A reduction in arable land in Belgium should thus be considered more in the context of food sovereignty.
- A consideration to be made is that livestock production in Belgium is not necessarily related to consumption in Belgium, livestock production is geared towards export.

Calorie shares of food groups in average EU food consumption in 2020 and 2045 → Fig. 11



Agora Agriculture based on CAPRI results

Protein content of average EU food consumption* in 2020 and 2045 → Fig. 12



Agora Agriculture. *gram per day per person; **Walpole et al. (2012)

Calorie share (above) and protein content (below) of food groups in average EU food consumption (2020 – 2045) in the study by AGORA (taken from (Agora Agriculture, 2024)).

- **Settlements (slide 22):** *0 ha growth by 2050 in Wallonia, 0 ha by 2040 in Flanders would result in an additional area of 12.000 ha in Wallonia and 18.000 ha in Flanders. Can we go further in the major change scenario?*
  - *SPW AWAC*: The areas still to be developed (18.000 ha in Flanders + 12.000 ha in Wallonia) are a maximum. There is a large potential in Wallonia to build

[9] Parcel Wallonie

in already urbanized areas. In Wallonia, additional built-up area is 85% residential, 15% consists of other use (e.g., industrial).

- New settlements/buildings can be established in already urbanized areas (through densification), so it does not necessarily lead to land use change/land take.
- It would be interesting to know more about population growth previsions and what does the scenario means in terms of m2/person if we stop building.
- The EU has the ambition to achieve no net land take by 2050, which should also be taken into consideration. According to the implemented regulations, both regions will comply to this European ambition.
- *Can the major change scenario be more ambitious and achieve no net land take earlier (e.g. 2030 or 3035)?*
  - There are also administrative issues (e.g. permits) to be considered.
  - The costs should also be considered of realizing no net land take (e.g., breaking down buildings in flood prone areas to rebuild in more appropriate regions). Some places must be moved (flooding) but are too expensive to destruct. If we want "no net land-take" then we have to destruct settlements that are not used anymore, and "give it back to nature". This should be integrated in the narrative.
- Settlements could be used as an adjustment variable instead of being defined first.

–

- **Forest management –** *10% harvest reduction* **(slide 23):**
  - There is a large demand for wood, exceeding current harvest levels (if more could be harvested, it would be. A considerable amount is exported to China. Going for a harvest reduction would need a change in the entire wood value chain. CRCF could provide an incentive or reward for use of Belgian wood products. In Wallonia, locally sourced wood is also promoted through the organization 'Filière Bois Wallonie'. However, harvest reduction could be balanced with additional afforestation.
  - Forests which are least adapted (and thus most vulnerable) to climate change (i.e., beech and spruce) can be prioritized for harvesting, in combination with the planting of more resilient species. Harvesting will then have to stop, so there will be an increase in forest harvesting in the process of establishing resilient stands, afterwards harvesting will decrease as forests are well adapted to climate change.
  - There could be a potential increase in demand for wood products due to trends in construction. This could lead to an increase in the carbon pool of harvested wood products (HWP) due to more wood products with a longer halftime, which fits into the Bioeconomy Strategy of the EU.
  - It should also be taken into consideration that the carbon sink of forests is capped due to the impact of climate change, e.g. on forest health or through an increase in wildfire.
  - In Wallonia, most forest (50%) are privately owned, so incentives and/or sensibilization of private owners should be considered. Wallonia already provides financial support for private forest owners as an incentive for more sustainable forest management.
  - It takes time to afforest areas, not all areas can be afforested at once.

- **Forest management –** *more resilient stands* **(slide 23):**
  - Resilient stands entail a diversity in forest age and in species.

  - Wallonia already provides financial support for forest owners to achieve more resilient stands through the Plan de relance de la Wallonie (Forêt Résiliente initiative).

- **Afforestation –** *+35.000 ha forest in Belgium (+1% of forest cover) – mostly in Flanders* **(slide 24):**
  - *Gembloux:* Between 1985 and 2000 forest cover in Belgium changed 6%, so achieving an increase of 1% is considered feasible.
  - Afforestation would be focused mainly in Flanders, as Wallonia already has a considerable share of forests, while in Flanders regional policies also aim to increase forest area. Though regional policies in Wallonia also aim to reforest Wallonia (focusing on restoring and regenerating forest by for instance transforming stands into resilient stands). Through the initiative of 'Yes We Plant' the goal is to plant an additional 1 million trees.
  - Any new forest should be resilient.
  - The CRCF regulation would not allow for land use change from productive land. The CRCF regulation establishes a voluntary system for certifying carbon removal activities, including carbon farming practices. It is thus unsure whether forest established on agricultural land would be eligible for carbon certification. Perhaps afforestation can be established on 'degraded' land (e.g., polluted land?).
  - *Can we go higher than 35.000 ha?*
    - The Nature Restoration Law does not include a specific afforestation target. Afforestation in the Flemish region is already proving challenging; the goal of 4000 ha will probably not be achieved.

- **Agricultural peatlands –** *Restoration of all agricultural peatlands (64.000 ha based on soil map of Belgium, including peaty substrate and texture). These peatlands are mostly situated in Flanders.* **(slide 25):**
  - Is paludiculture a valuable alternative to agriculture on these lands? Currently, there is no value chain for paludiculture, this would mean the value chain should be changed in a relatively short time frame.
  - Wetlands are also hotspots for biodiversity, restoring wetlands would thus increase biodiversity.

- **Agricultural management practices (slide 26):**
  - There are several tools/models which quantify carbon absorptions (e.g., RothC, CARAT (agroforestry)). It should be clearly indicated which tool is used.
  - Basic calculations are on the way, studies are in progress, but specific data on carbon absorptions does not yet exist for Belgium.
  - *Sytra* is critical on the carbon sequestration potential in agricultural land use and focuses instead on a change in emissions.
  - Some measures are close to a plateau (for instance cover crops in winter, there is few potential to increase the level of cover crops). Should in this regard a shift in main crops be considered or a shift in protein products for livestock?
  - A study by ILVO estimates that the mitigation potential of soil carbon farming ranges between 1.6% (based on feasible scenarios for the uptake of carbon farming measures) and 12–18% (based on technical potential to reach optimal SOC values in agricultural soils). Though there is technical potential, there are limitations for the uptake on carbon farming on the short term (e.g., lack of compost, biochar...). The economic and financial landscape should also be considered – some measures require a change in value chain or are associated with high costs. Enough economic stimuli should be included.

    - Agro-forestry should be also taken into account as well. There is little potential, but there is still potential.
    - In the context of CRCF, HAP soils (Highly Acidic and Peaty soils) are important and best numbers are achieved on these soils.

- **Protect biodiversity (slide 27):**
    - An extensification (e.g., through organic production) requires more area of land for the same production.
    - A parcel size of 5 ha would result in 10% semi-natural landscape features on agricultural land.

Major change scenario – Quadrants exercise

Following the scenario for a climate neutral EU proposed by Agora (Agora Agriculture, 2024), a reduction in meat consumption would lead to a reduction of 48% of cropland for feed. This translates in Belgium to approximately 183.000 ha of cropland becoming available for other land uses. After deducing areas designated to forest (35.000 ha), wetlands (7000 ha) and settlement areas (max. 30.000 ha), there is still additional (former crop)land available to allocate.

In a quadrant exercise, the participants were asked to discuss the possibility to allocate the remaining land to forest, grassland or cropland (for non-feed crops) and to assess the impact this allocation would have on:

- Climate mitigation
- Climate adaptation
- Biodiversity
- Food security
- Bioeconomy
- Cost
- Other

Below some discussion points are summarized for each land use change. In §0 **Quadrants Land use change** (below) summary tables and pictures of the quadrants can be found.

- **Conversion to grassland:**
    - More sequestration potential than cropland, but the sequestration potential depends on grassland management.
    - Grassland provides several ecosystem services, including cultural (landscape view), erosion control, pollination… They have the highest biodiversity potential.
    - Food production potential is lower than cropland. Secondary production can be derived in the form of meat and milk, biobased materials from hay or from green infrastructure. Given the reduction in livestock, extensive management of grasslands is possible.
    - Under current market conditions, the conversion of cropland to grassland would require Payment for Ecosystem Services (PES).
- **Conversion to forest land:**
    - Highest potential to sequester carbon in the LULUCF sector. Biodiversity potential depends on forest management.
    - There is a need to adapt species and varieties to the changing climate.
    - Harvested wood can have a long halftime and thus contribute to the Harvested Wood Products carbon sink.
    - Conversion to forest land would also require PES.
- **Remaining Cropland (non-feed crops):**

- Lowest sequestration potential of three options. Carbon farming could increase potential, but on the long term (depending on the availability of biomass). Scientific consensus is lacking on the effectiveness of biochar.
- Diversifying cropland with green landscape features and less monoculture would increase biodiversity and resilience. More availability of cropland would leave room for more organic agriculture, agroforestry and more sustainable agricultural practices (e.g., less soil compaction). Decreasing parcel size allows for more green infrastructure, however, smaller parcels have a lower cost-effectiveness.
- A shift to a more plant-based diet would require additional cropland for other crops such as legumes. Value chains need to be developed for non-food crops (e.g., hemp, miscanthus…).
- The current agricultural value chain is focused on animal-based agriculture.

Quadrants Land use change

Total conversion to grassland

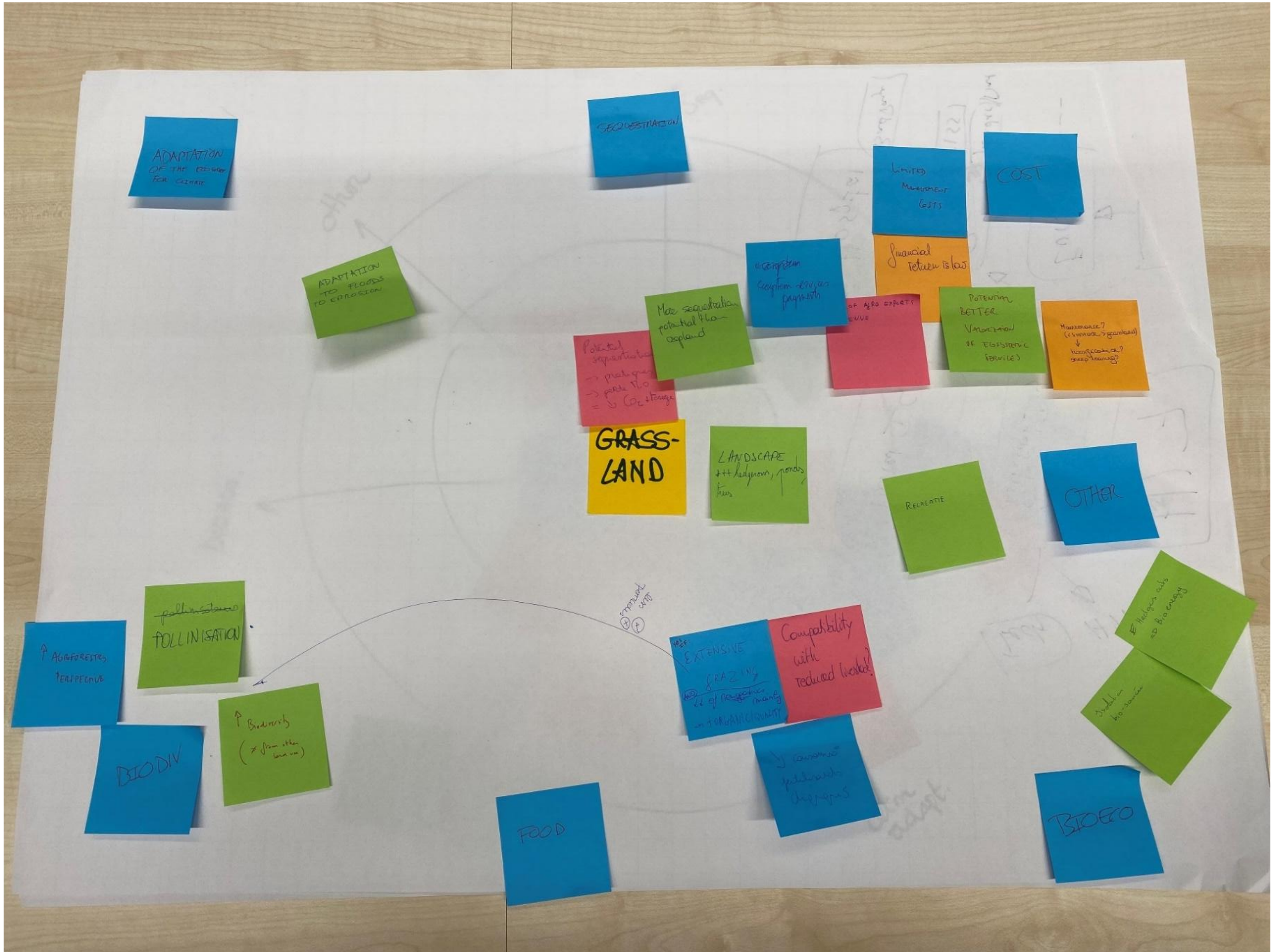
Climate mitigation	Sequestration (LULUCF sector) as compared to cropland, but sequestration potential heavily dependent upon how the grassland is being managed regarding organic matter (OM)	
Climate adaptation	Grasslands are less vulnerable when flooded, can be part of temporarily inundated zones Makes parcels, border less erosion prone	
Biodiversity	Positive effects for pollination when natural grasslands are managed accordingly In general highest biodiversity potential. Potential for landscape infrastructure with hedgerows, ponds and tree rows.	
Food security	Lower food production potential than cropland Agroforestry	
Bioeconomy	Requires removal of grass from the fields: either extensive grazing/rewilded grazing and/or haying Is this compatible with the reduction of livestock numbers? Agroforestry and landscape infrastructure yield additional food/biomass	Secondary production: meat and milk and/or biobased materials from hay additional biobased materials from the green infrastructure
Cost	Limited direct cost and limited management cost, but financial return is low Opportunity costs of cropland are higher Lower or no costs for inputs compared to cropland	Payment for ecosystem services (PES) required as grasslands are converted into cropland under current market conditions
Other	Recreation potential, cultural ecosystem service (landscape view)	Is there a potential to find synergies with the horsification trend (in Flanders)?

Total conversion to forest land

Climate mitigation	Highest potential to sequester carbon in the LULUCF sector compared to the other options.	Harvested Wood Products if productive forests
Climate adaptation	Need for adapted species and varieties (for example in 2100 our climate would compare to that of Nantes). Fire hazard! Erosion control Temperature control near cities.	
Biodiversity	Depending upon the type of forests (plantations?), the species planted and their management.	
Food security	Less than the other options, though hunting opportunities and potential for food forests.	
Bioeconomy	Timber products from productive forests can have a long lifetime if well applied	
Cost	Investment peak when starting, then a long time without income, employment nor ROI, but with maintenance costs. Land tenure very important as owner might want a more immediate return.	Need for PES system (cf. Danish system)
Other	Recreation potential, but closed landscape, quid social acceptance. More need to reforest in Flanders	

Cropland remaining cropland but with non-feed crops

Climate mitigation	Lowest sequestration potential of the 3 options. Potential could be increased through the application of biochar, though in the long term and dependent upon availability. Scientific consensus on the effectiveness of biochar, however, is lacking.	
Climate adaptation	Less monoculture would increase resilience. Peatland in agricultural use in controlled flooding areas	
Biodiversity	Conventional cropland and especially monoculture is bad for biodiversity. If at the same time the landscape receives green infrastructure and extensification of cropland management is pursued, this could be beneficial. More availability of land could be a motor for more organic agriculture, more sustainable agricultural practices (less soil compaction caused by heavy machines) and parcel size decrease to allow for more green infrastructure and buffer strips.	Cost-effectiveness of smaller parcels is lower
Food security	Crop type needs to be taken into account. Additional need for plant protein due to changed diets requires other crops such as legumes etc. What does food security mean? – for some products? At BE level? At EU level? Local production of feed (rapeseed). Reduce the imports of soy.	
Bioeconomy	Non-food crops (hemp, miscanthus etc.) Agroforestry	! market is not ready yet, value chains need to be developed as well as biomass hubs. Agroforestry has many secondary effects to the other aspects (food, adaptation, biodiversity, bio-economy)
Cost	Current agricultural value chain (and support schemes) is focused on animal-based agriculture	
Other		


SEQUESTRATION
LIMITED MANAGEMENT COSTS
COST
ADAPTATION TO FLOODS TO EROSION
Financial return is low
POTENTIAL BETTER VALORISATION OF ECOSYSTEM SERVICE
GRASS-LAND
LANDSCAPE
RECREATIE
OTHER
POLLINISATION
BIODIV
EXTENSIVE GRAZING
Compatibility with reduced livestock?
FOOD
BIOECO


ADAPT
SEQ
COST
BIODIV
FOOD
OTHER
BIOECON.
FOREST LAND
EROSION FLOOD → CONTROL TEMPERATURE
FIRE HAZARD
IF RESILIENT SP.
CO2 SEQUESTRATION (IF LUC TOWARDS FOREST)
LAND TENURE + EMPLOYMENT + ECONOMICAL LOSS FOR OWNER + ...
START INVESTMENT HIGH FOR LUC
MAINTAINING FOR PRODUCT. (FOR THE GOV.
COST HIGH
LONG PERIOD BEFORE RETURN ON INVESTMENT
PES Payment for Ecosystem Services
not if changed from livestock feed cropland
Need to diversify ecosystems
→ Not only forests
BIO DIV (DEPENDING ON THE FOREST AND THE LUC)
TIMBER PRODUCT
LONG LIFE CYCLE OF THE TIMBER PRODUCT.
RECREATION
"closed" landscape?
social acceptance?
GAME HUNTING
POOR FOOD PRODUCTION


Seq.
food security
other
bioeco.
LAND
biodiv.
clim adapt.
AGROFORESTRY
less cost-effective

ANNEX 2: SCENARIO MAJOR LAND USE CHANGE – REVIEW

Agora – Agriculture, forestry and food in a climate neutral EU

Reference

Agora Agriculture. (2024). *Agriculture, forestry and food in a climate neutral EU. The land use sectors as part of a sustainable food system and bioeconomy.* Retrieved from https://www.agora-agriculture.org/fileadmin/Projects/2024/2024-09_EU_Agriculture_forestry_and_food_in_a_climate_neutral_EU/AGR_336_Land-use-study_WEB.pdf

Region

European Union

Short description

A comprehensive scenario is presented for transforming the European Union's land use sectors to achieve climate neutrality by 2045. The scenario describes a transition of the agriculture, forestry, and food sectors to climate neutrality while maintaining food security, enhancing biodiversity, and supporting the bioeconomy. The main building blocks of the scenario are a more efficient land use combined with a more sustainable demand for food, feed, and other biomass.

Key findings

- Healthier and more sustainable diets are necessary to reduce pressure on land.
- More efficient land use is required to balance the needs for carbon storage, food production, and ecosystem health.
- Reversing biodiversity loss in farmland is possible through sustainable land management.
- Increased biomass production for bio-based industries can be achieved without compromising food supply.

Main measures (with an impact on natural carbon sinks)

- Shift toward more plant-based diets to reduce land-use pressure.
    - Annual average reduction of 3% resulting in -51% meat consumption by 2045 (-60% or -3.6% annually in beef consumption, -67% or -4.3% annually in pork consumption and -18% or -0.8% annually in poultry meat consumption)
- More efficient livestock farming (with a focus on dairy production) with reduced herd sizes and extensive grazing on permanent grasslands.
    - Increasing forage in ruminant diets through extensive grazing (1.12 livestock units/ha grassland in 2045), which also positively affect biodiversity
    - Area of permanent grassland is kept constant
- Restoration of peatlands to halt emissions and enhance carbon storage.
    - Rewetting 80% of drained agricultural peatlands, 80% of which is used for paludiculture and 20% is turned into wet wilderness and solar photovoltaics
    - Using 20% of agricultural peatlands as shallow-drained – with an average annual water table of about 30 cm below the surface grassland – used as extensive pasture
- Multifunctional arable farming, which is productive under variable environmental conditions, while maintaining ecosystem health.

    - By 2045 soil organic carbon stocks in cultivated arable soils remain constant, implying targeted efforts in crop-rotation design (increase soil rooting), recycling of plant residues, soil tillage and fertilisation
    - 20% semi-natural landscape features in agricultural landscapes (approximately 1% of productive arable land set aside, 4% to be farmed as semi-natural arable land or other arable production compatible with biodiversity conservation (e.g., agroforestry systems))
    - Production of vegetables, fruits and pulses increases, cereal production decreases by 26% (due to a lower demand for animal feed)
- Reforestation, afforestation and sustainable forest management to increase biomass carbon sequestration.
    - Adapting forests towards resilient stands by changing species composition and forest structure
    - 10% reduction in harvest in targeted forest areas
    - Increasing active afforestation (5 million ha of afforestation by 2045)

Policy incentives

- Incentives for farmers & foresters to adopt climate-friendly practices.
- Stronger EU policies aligning agriculture, forestry, and climate goals.
- Integration of carbon pricing and subsidies for climate-smart land management.

Pathways for 2050 – 'Behaviour'-scenario

Reference

FPS Public Health, DG Environment, Climate Change Section. (2021). *Scenarios for a climate neutral Belgium by 2050.* Retrieved from https://climat.be/doc/climate-neutral-belgium-by-2050-report.pdf

Region

Belgium

Short description

This report explores potential pathways for Belgium to achieve net-zero greenhouse gas emissions by 2050. Using the 2050 Pathways Explorer, a comprehensive model that identifies over 100 levers across various sectors, the report assesses technological, economic, and behavioral changes across key sectors such as energy, industry, transport, buildings, and land use. The aim is to provide data-driven insights to support policymakers in designing an effective and feasible decarbonization strategy while balancing economic and social considerations. The 'Behaviour'-scenario focuses on achieving climate neutrality primarily through societal and lifestyle changes rather than relying heavily on technological advancements. This scenario assumes that individuals and businesses adopt more sustainable behaviors, leading to significant reductions in energy demand and emissions.

Key findings

- Behavioural changes can significantly contribute to emission reductions, complementing technological solutions.
- Societal acceptance and active participation are critical for the success of measures focused on behaviour.

Main measures (with an impact on natural carbon sinks)

- Shift towards plant-based diets, reducing meat and dairy consumption, and general decrease in food consumption (-34% kcal/cap/day).
- Expansion of sustainable farming practices, reducing fertilizer and pesticide use, and implementing agro-ecological practices (reducing crop yields with 25%).
- Increasing forage in ruminant diets (+40% pastures in animal feed).
- Surplus land, freed up by the impact of other levers, is allocated to afforestation (27%), natural prairies (27%) and non-food agriculture (47%)

Policy incentives

- Requires strong public engagement and policy incentives to encourage widespread adoption of sustainable behaviors.

Planbureau voor de Leefomgeving – Trajecten naar een 'klimaatneutrale' landbouw, landgebruik en glastuinbouw in 2050 (Trajectories towards climatneutral agriculture, land use and greenhouse agriculture)

Reference

PBL. (2024). *Trajecten naar een 'klimaatneutrale' landbouw, landgebruik en glastuinbouw in 2050.* Den Haag: Planbureau voor de Leefomgeving. Retrieved from https://www.pbl.nl/system/files/document/2024-04/pbl-2024-trajecten-naar-een-klimaatneutrale-landbouw-landgebruik-glastuinbouw-5202.pdf

Region

Netherlands

Short description

The study explores potential developments and interventions required in Dutch agriculture, land use, and greenhouse horticulture to achieve climate neutrality by 2050. Three distinct pathways were explored, entitled 'Climate Basic', 'Climate Plus' and 'Nature and Climate'. These pathways differ in the extent and combination of measures taken to reduce greenhouse gas emissions: each pathway explores a different balance between technological solutions, land-use changes, and intensity of agricultural practices.

Key findings

The study finds that a significant reduction in greenhouse gas emissions is possible, however, this reduction requires significant measures, including livestock reductions, interventions in management practices and land use change. Despite these measures, the Dutch agricultural sector is projected to remain a source of greenhouse gas emissions. In the Netherlands, the land use sector is also a source of greenhouse gas emissions, which can be reduced from 4.3 Mton CO_2eq to 0.3 Mton CO_2eq in the 'Climate Plus' pathway and 0.5 Mton CO_2eq in the 'Nature and Climate' pathway. The emission reduction in both pathways is mostly due to the rewetting of peatlands and afforestation. These measures require time to reach their full sequestration potential, it is therefore important to implement these measures early and on a large enough scale.

Many emission reduction strategies also positively impact other environmental challenges, such as nitrogen reduction, biodiversity enhancement, and water quality improvement. Measures like agricultural extensification, livestock reduction, and afforestation can yield multiple environmental benefits.

Main measures (with an impact on natural carbon sinks)

- **Livestock reduction:** in all three pathways livestock is reduced, especially in 'Climate Plus' and 'Nature and Climate' with resp. 40 – 50% and 50 – 60%.
- **Rewetting peatlands:** the groundwater table is raised to -40 cm ('Climate Plus') or to -20 cm ('Nature and Climate'). Peatland is taken out of agricultural cultivation and restored to natural areas.
- **Afforestation**: In both the 'Climate Plus' and 'Nature and Climate' pathways 90.000 ha of afforestation is foreseen in combination with 8000 individual trees. Forest management differs between both pathways, 'Climate Plus' aimed at wood production, while 'Nature and Climate' focuses on biodiversity.

ADEME – Transition(s) 2050

Reference

ADEME. (2021). *Transition(s) 2050.* Agence de la transition écologique (ADEME). Retrieved from https://librairie.ademe.fr/ged/6531/transitions2050-rapport-compresse2.pdf

Region

France

Short description

This study outlines four distinct scenarios for France to achieve carbon neutrality by 2050, each reflecting different societal choices and technological pathways: 'Frugal Generation' (Génération Frugale), 'Territorial Cooperation' (Coopérations Territoriales), 'Green Technologies' (Technologies Vertes) and 'Restorative Bet' (Pari Réparateur). Among the four scenarios, 'Frugal Generation' and 'Territorial Cooperation' place the strongest emphasis on increasing natural carbon sinks. 'Frugal Generation' prioritizes large-scale land restoration, including afforestation and wetland protection. A lower consumption of animal products and a strong reduction in livestock farming leads to a lower pressure on land, leaving more land available for carbon sequestration. This scenario realizes the largest natural carbon sink. 'Territorial Cooperation' focuses on a balance between food production and ecological restoration. This scenario includes a moderate livestock reduction, combined with a shift towards agroecology. Land is freed up for agroforestry, afforestation and wetland restoration. In contrast, the "Green Technologies" and "Restorative Bet" scenarios rely more on engineered solutions (e.g., BECCS, direct air capture, or carbon storage technologies) rather than natural sinks. However, they still integrate afforestation and improved land use management to some extent.

Key findings

The study finds, among other things, that living organisms are one of the main assets to transition to climate neutrality, allowing the combination of three strategic levers: carbon storage, biomass production, and greenhouse gas reduction. It is therefore essential to maintain a balance between the food and energy uses of biomass, while preserving ecological functions, such as biodiversity and carbon storage, through a global bioeconomy approach. The adaptation of forests and agriculture therefore becomes absolutely essential to combat climate change. The resilience of ecosystems is all the more crucial as they increasingly suffer from the impacts of climate change.

Main measures (with an impact on natural carbon sinks)

- **Reduction in meat consumption** leading to a reduction in livestock farming – a reduction of 2/3 in 'Frugal Generation' and 50% reduction in 'Territorial Cooperation'
- **Afforestation**: each scenario contains afforestation efforts, in 'Frugal Generation' this involves extensive forest management focusing on carbon sequestration.
- **Agroforestry and sustainable agriculture**: agroforestry practices are integrated to promote biodiversity and soil health.
- **Wetland and peatland restoration:** Significant focus on restoring wetlands to act as natural carbon sinks in 'Frugal Generation', in 'Territorial Cooperation' this is achieved in cooperation with local stakeholders.
- **Soil carbon sequestration:** Promoting regenerative agriculture, including cover crops, reduced tillage, and organic amendments to improve soil carbon storage. Perennial crops and deep-rooted plants are increased and grassland is restored. These measures are mainly implemented in 'Frugal Generation'.

Agreement for a greener Denmark

Reference

Danish Government. (2024). *Aftale om en grøn Danmark [Agreement on a Green Denmark].* Copenhagen: Danish Government. Retrieved from https://regeringen.dk/media/ng3b13va/aftale-om-et-groent-danmark.pdf

Ministry of Green Transition. (2024). *A Greener Denmark.* Retrieved from https://mgtp.dk/groent-danmark/english-a-greener-denmark

Region

Denmark

Short description

Denmark has implemented a comprehensive plan to transition towards a greener and more sustainable future, addressing climate change and environmental degradation. The initiative aims to significantly reduce greenhouse gas emissions, enhance carbon sequestration, and promote sustainable agriculture and energy practices. This strategy is designed to align Denmark with international climate commitments and set a precedent for environmental stewardship.

Main measures (with an impact on natural carbon sinks)

- Reforestation and Land Conversion:
    - Planting 1 billion trees over the next 20 years.
    - Converting 10% of farmland (approximately 250 000 hectares) into forests and natural habitats.
    - Transforming an additional 140 000 hectares of low-lying, climate-vulnerable soils into natural habitats.
    - Allocating about 6 billion euros to acquire farmland for these purposes.
- Agricultural Emission Reductions:
    - Implementing a tax on greenhouse gas emissions from livestock starting in 2030.
    - Encouraging the production and consumption of plant-based foods, supported by a €170 million government fund.

Nature Restoration Law

Reference

European Union. (2024). Regulation (EU) 2024/1991 of the European Parliament and of the Council of 17 June 2024 on nature restoration. *Official Journal of the European Union, L1991*. Retrieved from http://data.europa.eu/eli/reg/2024/1991/oj

Region

European Union

Short description

The Nature Restoration Law is a landmark regulation enacted by the European Union to address the decline of biodiversity and the degradation of ecosystems across Europe. As a core component of the European Green Deal and the EU Biodiversity Strategy, the law establishes binding targets to restore degraded ecosystems, particularly those with significant potential for carbon sequestration and climate resilience.

Main measures (with an impact on natural carbon sinks)

- Habitat Restoration Targets:
  - The law covers forests, wetlands, grasslands, rivers, and marine ecosystems.
  - Restore at least 30% of degraded habitats to a favorable condition by 2030, with progressive increases to 60% by 2040 and 90% by 2050.
- Specific Ecosystem Initiatives:
  - Urban Green Spaces: Ensure a minimum of 10% tree canopy cover in European cities and towns.
  - Agricultural Ecosystems: Increase the biodiversity-rich landscape features (e.g., hedgerows, flower strips) on agricultural land.
  - Forest Ecosystems: Implement measures to restore forest biodiversity and enhance resilience.
- Peatland Restoration:
  - By 2030: Restore at least 30% of drained peatlands, with at least 25% of these areas undergoing rewetting.
  - By 2040: Increase the restoration to 40% of drained peatlands.
  - By 2050: Achieve restoration of 50% of drained peatlands, ensuring that at least one-third of these areas are rewetted.
  - Alternative Land Use Practices: Promote sustainable practices such as paludiculture (wet agriculture) on rewetted peatlands, allowing for continued agricultural use while maintaining ecological functions.

ETC-CA – Management Options for Increasing the Mitigation Potential in the LULUCF Sector

Reference

ETC-CA. (2022). *Management options for increasing the mitigation potential in LULUCF sector (ETC/CA Report 1/2022).* Retrieved from https://www.eionet.europa.eu/etcs/etc-ca/products/etc-ca-products/etc-ca-report-1-22-management-options-for-increasing-the-mitigation-potential-in-lulucf-sector

Region

European Union

Short description

The report aims to identify land management options that can enhance the mitigation potential of the Land Use, Land-Use Change, and Forestry (LULUCF) sector in Europe. It aligns with EU climate goals, particularly the 'Fit-for-55' package and the EU's climate neutrality target by 2050. The study explores land-based mitigation strategies that also support biodiversity conservation and climate adaptation, while ensuring they do not negatively impact other ecosystem services.

Key findings

- Achieving climate neutrality in the LULUCF sector requires a combination of afforestation, soil carbon management, peatland restoration, and sustainable forestry.
- Implementing these measures effectively will help double the EU's LULUCF carbon sink from 256 Mt CO_2eq/year (2017-2019) to 425 Mt CO_2eq/year by 2050, while supporting biodiversity and ecosystem resilience.

Main measures (with an impact on natural carbon sinks)

- **Land use change (transition to land uses with higher carbon stocks)**
  - Afforestation and reforestation of cropland or grassland
  - Conversion of cropland to grassland
- **Land Management (improving carbon sequestration and reducing emissions)**
  - Soil carbon enhancement in croplands through cover crops, reduced tillage, and agroforestry
  - Biochar application to improve soil carbon storage
  - Sustainable forest management (selective logging, extended rotation periods, natural regeneration, deadwood retention, mixed species plantations...) to increase carbon sequestration, while maintaining productivity
  - Management of agricultural residues (e.g., mulching, incorporation into the soil...) to reduce emissions
- **Restoration and protection of existing carbon stocks**
  - Peatland restoration and rewetting to reduce CO_2 emissions from drained peatlands
  - Restoration of degraded forests to improve carbon sequestration
  - Avoided deforestation and ecosystem conservation to prevent carbon losses

European Environment Agency (EEA) – Enhancing Europe’s Land Carbon Sink

Reference

European Environment Agency. (2024). *Enhancing Europe's land carbon sink: status, challenges and opportunities (Draft report).* Copenhagen: European Environment Agency.

Region

European Union

Short description

The report assesses the status, challenges, and opportunities for enhancing the carbon sequestration potential of Europe’s land sector, particularly within the LULUCF sector. It highlights the declining trend in the EU’s land-based carbon sink over the past decade and identifies measures to reverse this trend and increase carbon removals to meet EU climate targets.

Key findings

- Forests and peatlands are Identified as the largest carbon sinks, but their capacity is declining due to aging forests and land degradation.
- Reduced tillage, crop diversification, and cover cropping increase soil carbon storage in arable land.
- Rewetting peatlands offers the highest mitigation potential per hectare.
- Expanding urban forests and green roofs contributes to local carbon absorption.
- Reducing livestock production would free up land for forests and grasslands.

Main measures (with an impact on natural carbon sinks)

- Forests
  - Afforestation and reforestation to increase biomass carbon storage.
  - Sustainable forest management (longer rotation periods and selective logging) to enhance sequestration while maintaining timber production.
  - Reducing harvest intensity to slow the loss of carbon stocks.
  - Prevent deforestation through strict zoning laws.
- Cropland and grassland
  - Agroforestry to integrate trees into agricultural landscapes.
  - Improved soil management (e.g., no-till, cover crops, biochar, organic farming...) to enhance soil organic carbon.
  - Grassland restoration to increase soil carbon storage.
- Wetlands and peatlands
  - Rewet peatlands to halt carbon losses from drained peat soils.
  - Protect wetlands to prevent the conversion to agricultural or urban use.
- Settlements
  - Green infrastructure expansion in urban areas to enhance local carbon sequestration.
  - Soil sealing reduction to maintain carbon absorption capacity.

Policy incentives

- EU Climate and LULUCF Regulation (Target: -310 $MtCO_2eq$ removals by 2030).
- Common Agricultural Policy (CAP): Incentives for sustainable land management (e.g., through the promotion of agroecological practices).

- Carbon Removal Certification Framework: Standardizing and financing carbon sequestration projects (e.g., providing subsidies for verified carbon storage improvements).
- Improved Monitoring, Reporting & Verification (MRV) using geospatial datasets to track land-based carbon fluxes.
- Zoning and land use regulations Preventing further loss of forests and wetlands.

ANNEX 3: OVERVIEW OF SECTORS AND PRODUCTS CONSIDERED IN PART 2 AND DISTRIBUTION OF THE TOTAL CULTIVATED AGRICULTURAL AREA

Table 65: Plant-based sectors and products grown in Belgium and considered in the model.

Category	Sector	Product
Plant-based sectors	Fruits	Pears
		Apples
		Cherries
		Other orchards (walnuts)
		Strawberries open-air
		Strawberries greenhouse
		Other small fruit open-air (grapes)
		Other small fruit greenhouse (raspberries)
	Open-air Vegetables	Green peas
		Green beans
		Onions
		Carrots
		Cauliflowers
		Brussels sprouts
		Leeks
		Witloof roots
		Spinach
		Celeriac
		Asparagus
		Other vegetables (average of all vegetables)
	Greenhouse Vegetables	Greenhouse tomatoes
		Other greenhouse vegetables (lettuce)
	Cereals	Winter wheat
		Spring wheat
		Winter barley
		Spring barley
		Spelt
		Triticale
		Rye and meslin
		Oats and summer mix
		Grain maize
		Other cereals
	Potatoes	Potatoes
	Sugar beet	Sugar beet
	Other industrial crops	Flax
		Rapeseed
		Other oil-rich crops

	Protein-rich crops (legumes)	Protein-rich peas
		Beans and faba beans
		Other legumes harvested as dry beans
	Forage crops	Forage maize
		Forage beet
		Forage legumes
		Other forage crops
	Grassland	Permanent grassland
		Temporary grassland

Table 66: Animal sectors bred in Belgium and considered in the model.

Category	***Sector***	***Product***
Animal sectors	Bovine meat - breeding	Suckler cows
	Bovine meat - fattening	Young bulls
	Dairy	Dairy cows
	Eggs	Laying hens Reproductive hens Young hens
	Pork	Productive pigs Reproductive pigs (sows)
	Poultry	Broilers

Table 67 : Average area of main products in Belgium in 2018-2022 (reference Statbel).

Sector	Product	Area (ha)	% of UAA
Grassland	TOTAL	568839	42,6
	Permanent grassland	475096	35,6
	Temporary grassland	93743	7,0
Cereals	TOTAL	310024	23,2
	Winter wheat	183882	13,8
	Grain maize	53043	34,0
	Winter barley	39570	3,0
	Spelt	14774	1,1
	Triticale	5199	0,4
	Spring barley	3817	0,3
	Oats and summer cereal mix	3629	0,3
	Other cereals	3216	0,2
	Spring wheat	2162	0,2
	Rye and meslin	731	0,1
Forage crops	TOTAL	193846	14,5
	Forage maize	179396	13,4
	Forage legumes	5654	0,4
	Forage beet	4916	0,4
	Other forage crops	3880	0,3
Fruits	TOTAL	19905	1,5
	Pears	10361	0,8
	Apples	5668	0,4
	Cherries	1145	0,1
	Strawberries open-air	798	0,1
	Small open-air fruit	782	0,1
	Strawberries greenhouse	633	0,1
	Other orchards	398	<0,1
	Other greenhouse fruit	120	<0,1
Greenhouse vegetables	TOTAL	3882	0,3
	Other greenhouse vegetables	3303	0,3
	Greenhouse tomatoes	579	<0,01
Legumes	TOTAL	6531	0,5

	Other legumes harvested as dry seeds	4683	0,4
	Beans and faba beans	1159	0,1
	Protein-rich peas	688	0,1
Other industrial crops	TOTAL	24699	1,9
	Flax	15699	1,2
	Rapeseed	9000	0,7
Open-air vegetables	TOTAL	55778	4,2
	Peas	11082	0,8
	Other vegetables	8366	0,6
	Beans	7360	0,6
	Cauliflower	5572	0,4
	Onions	4415	0,3
	Carrots	4347	0,3
	Spinach	4187	0,3
	Leeks	4024	0,3
	Brussels sprouts	2863	0,2
	Witloof roots	2192	0,2
	Celery root	807	0,1
	Asparagus	563	<0,01
Potatoes	Potatoes	93914	7,0
Sugar Beet	Sugar beet	56915	4,3
Total		**1334333**	**100,0**

ANNEX 4: PART 2 – ACTION 2: DEFINE THE USE OF PRODUCTION

Action 2 is divided into two tasks (Action 2 is divided into two tasks. Each of these tasks responds to an objective:

- Task 1: Define and categorize the types of use of production;
- Task 2: Match agricultural systems and the use of production.

). Each of these tasks responds to an objective:

1. Task 1: Define and categorize the types of use of production;
2. Task 2: Match agricultural systems and the use of production.

Use of production

Five distinct uses of agricultural land in Belgium are identified, based on the final destination of production:

1. Feed – allocated to animal feed;
2. Food – intended for human consumption;
3. Bioenergy – utilized for bioenergy production;
4. Exports – designated for export outside Belgium;
5. Other uses – uses not included in the above categories, including, for example, textile production.

Limitations and needs

Currently, very little reliable data is available, and the information that does exist is often incomplete or inconsistent with FAO supply balance sheets (Commission Horticulture Comestible, 2018). This scarcity is mainly due to the sensitive nature of agricultural data, with producer federations often refraining from publishing official statistics. To address this gap, we cross-referenced multiple data sources and consulted key stakeholders. Ideally, it would be possible to provide detailed information on the proportion of uses for each crop within each plant-based sector. However, current datasets do not yet allow for this level of granularity. Moreover, existing data do not permit a clear distinction between regions. For instance, in the case of cereals, it is not possible to determine whether the share produced for feed purposes differs between Wallonia and Flanders. Stakeholders repeatedly emphasized the urgent need for more comprehensive, regularly updated data and called for harmonized data collection and reporting practices across regions.

This lack of detailed national data has also been acknowledged in other major studies. For instance, the Valbiom et al. report (2023) draws on the same data source we used—namely, the Plan de développement stratégique of the Collège des Producteurs (2018). In this plan, the authors explicitly point out the data limitations: "*Il y a peu de données disponibles à l'échelle de la Belgique. Beaucoup de données sont sensibles et les fédérations ne publient pas forcément des statistiques officielles. De plus, les données disponibles ne distinguent pas les différentes utilisations.*"

As a result, like our own work, the VITO and Valbiom study relies on expert interviews to make estimations—further underscoring the need for more robust and transparent data collection in the sector.

Results

As demonstrated in Table 68 and Table 69, more than 950,000 hectares of Belgian agricultural land are utilized for animal feed, constituting 72% of the country's total agricultural land utilisation. In contrast, a mere 6% of agricultural land is dedicated to producing human food through crop cultivation. Exports play a significant role in shaping the Belgian agricultural landscape, with 16% of land being cultivated explicitly for export purposes. The following sections provide more information on specific plant-based sectors.

Table 68: Distribution of cultivated agricultural area in Belgium (expressed in hectares) for each plant-based sector per use (2018-2022)

Plant-based sectors	Energy (ha)	Exports (ha)	Feed (ha)	Food (ha)	Others (ha)
Cereals	69550	25698	189078	25698	
Forage crops			193846		
Fruits		11328		8577	
Greenhouse vegetables		3106		776	
Protein-rich crops (Legumes)			4683	1847	
Other industrial crops	2700			6300	15699
Open-air vegetables		47310		8468	
Grassland			568839		
Potatoes		75131		18783	
Sugar Beet		45532		11383	
Total	**72249**	**208105**	**956447**	**81833**	**15699**

Table 69: Different uses of agricultural land in Belgium (expressed in % of crop UAA) in the current situation (2018-2022).

Plant-based sectors	Energy (%)	Exports (%)	Feed (%)	Food (%)	Others (%)	Total (%)
Cereals	22	8	61	8	0	100
Forage crops	0	0	100	0	0	100
Fruits	0	57	0	43	0	100
Greenhouse vegetables	0	80	0	20	0	100
Protein-rich crops (Legumes)	0	0	72	28	0	100
Other industrial crops	11	0	0	26	64	100
Open-air vegetables	0	85	0	15	0	100
Grassland	0	0	100	0	0	100
Potatoes	0	80	0	20	0	100
Sugar Beet	0	80	0	20	0	100
Total	**5**	**16**	**72**	**6**	**1**	**100**

Cereals

According to Delcour et al. (2014), the processing of cereals for human consumption in Belgium primarily involves milling and malting. Milling activities are concentrated in Flanders and rely on wheat sourced from Wallonia (14%), Flanders (1%), and imports (85%), mainly from France and Germany (Antier, et al., 2019). However, it is worth noting that the data from Delcour et al. dates back more than a decade.

According to stakeholders interviewed in 2023, the use of cereals as fodder is likely more prevalent in Flanders than in Wallonia. Conversely, the share of cereal production intended for human consumption appears to be lower in Flanders compared to Wallonia. Stakeholders also noted that the proportion of cereals used for feed varies significantly depending on the specific crop.

Grassland and forage crops

These two sectors, grassland and forage crops, are fairly easy to categorise by use, since they are both intended for animal feed and are therefore assigned to the “feed” category.

Fruits

A significant proportion of fruit production is exported. For instance, in Belgium, the Collège des Producteurs (2018) has reported that 50% of apples and 70% of pears produced are exported. On average, 57% of the fruit produced across the entire sector is destined for export.

Open-air vegetables

It is difficult to distinguish the regional distribution of open-air vegetable use and, consequently, to differentiate between Wallonia and Flanders. Stakeholders explained that the majority of vegetables (as well as fruits) are marketed through Flemish auction houses or certain private commercial platforms. The open-air vegetables sector, akin to that of greenhouse vegetables, is responsible for the production of two primary destinations: firstly, vegetable production for the fresh market, and secondly, vegetable production for the processing market (frozen, canned), known as "industrial vegetables". These products are very often exported (Commission Horticulture Comestible, 2018).

Potatoes

According to the study by Antier et al. (2019), potatoes in Wallonia are marketed through two main channels: potatoes for sale and potatoes for processing, which account for around 20% and 80% of national production respectively. Potato production is mainly used for human consumption - both nationally and for export (Antier, et al., 2019).

Sugar Beet

The stakeholders interviewed confirmed that no sugar beet is used in the production of biofuels or other forms of energy.

Matching productions systems and use of production

The previous section highlighted the difficulty of obtaining reliable information on crop uses (food, feed, energy, export or other) due to a lack of data. Consultations with various experts partly overcame this lack of data. Currently, it is also not possible to link crop use to production systems. Production systems are determined based on agricultural practices for each plant-based sector; in our case, this is done through organic certification, which dictates the use of inputs. Since it is not possible to link organic certification to uses, it is not possible to link production systems to these uses. For example, there is no information available to determine whether cereals intended for animal feed are managed more or less organically than those intended for human consumption.

However, we can assume that when a farmer knows the end use of his production (e.g., for human consumption), he will adapt his practices (choice of varieties, use of fertilizers, pesticides, etc.) to optimize certain parameters (quality, productivity, etc.). From this perspective, it would also be relevant to link farmers’ economic constraints to their technical itineraries. If producing more biomass for animal feed or energy is sufficiently profitable, the farmer will be motivated to use more fertilizers or pesticides to increase production. It can also be assumed that organic production methods are intended more for human consumption, although organic animal feed is also required for the organic livestock sector.

Furthermore, in specific sectors, collectors or manufacturers have the capacity to impose specific agricultural practices via precise specifications to meet specific criteria (e.g., baby food). These specifications could enable technical itineraries to be differentiated according to market outlets.

Different uses of land

Indicator description

This indicator shows how agricultural land is used and the final destination of the produce, whether it is used for feed, food, energy, exports or other purposes. It reflects the specific allocation of crop production for various purposes, such as food and feed. This indicator is not an output of the model per se, but rather a supporting variable.

Scenario results

Due to a lack of data, we are assuming that the shares shown in Table 69 remain constant across the different scenarios. Overall, around 800,000 – 900,000 hectares of agricultural land remain used for producing animal feed. Throughout the scenarios, this represents 72% of Belgian agricultural land use. In contrast, only 6% of agricultural land is used directly for human consumption through crop cultivation (cf. Table 69). Exports play an important role in the Belgian agricultural landscape since 16% of the land is cultivated for export.

Table 70: Different uses of agricultural land in Belgium in the current situation (2018-2022) and the three scenarios in 2050 (ha).

Uses of agricultural land	2018 – 2022 Scenario 0 Current situation (ha)	2050 Scenario 1 Reference (ha)	2050 Scenario 2 Policy (ha)	2050 Scenario 3 Major Change (ha)
Energy	72 249	75 139	70 805	58 941
Exports	208 105	215 027	204 644	174 439
Feed	956 447	875 743	927 910	844 276
Food	81 833	84 631	80 434	68 307
Others	15 699	16 327	15 385	12 795
Total	**1 334 333**	**1 266 868**	**1 299 177**	**1 158 759**

ANNEX 5: ANNUAL FLUX CALCULATIONS IN FORESTS FOR THE DIFFERENT SCENARIOS

Reference scenario

Table 71: Annual Flux calculation under the reference scenario for Wallonia

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	0.69368	0.69368	0.69368	0.69368	0	0.01	0.01	1.04	1.04	0.18	0.23	0.82	0.87
2	2027	0.69368	0.69368	1.38736	1.38736	0	0.01	0.01	1.04	1.04	0.18	0.23	0.82	0.87
3	2028	0.69368	0.69368	2.08104	2.08104	0	0.02	0.02	1.04	1.04	0.18	0.23	0.83	0.88
4	2029	0.69368	0.69368	2.77472	2.77472	0	0.02	0.03	1.04	1.04	0.18	0.23	0.83	0.88
5	2030	0.69368	0.69368	3.4684	3.4684	0	0.03	0.03	1.04	1.04	0.18	0.23	0.84	0.89
6	2031	0.69368	0.69368	4.16208	4.16208	0	0.03	0.04	1.04	1.04	0.18	0.23	0.84	0.89
7	2032	0.69368	0.69368	4.85576	4.85576	0	0.04	0.05	1.03	1.03	0.18	0.23	0.84	0.90
8	2033	0.69368	0.69368	5.54944	5.54944	0	0.04	0.06	1.03	1.03	0.18	0.23	0.85	0.90
9	2034	0.69368	0.69368	6.24312	6.24312	0	0.05	0.06	1.03	1.03	0.18	0.23	0.85	0.91
10	2035	0.69368	0.69368	6.9368	6.9368	0	0.05	0.07	1.03	1.03	0.18	0.23	0.85	0.92
11	2036	0.69368	0.69368	7.63048	7.63048	0	0.06	0.08	1.03	1.03	0.18	0.23	0.86	0.92
12	2037	0.69368	0.69368	8.32416	8.32416	0	0.06	0.08	1.03	1.03	0.18	0.23	0.86	0.93
13	2038	0.69368	0.69368	9.01784	9.01784	0	0.07	0.09	1.03	1.03	0.18	0.23	0.87	0.93
14	2039	0.69368	0.69368	9.71152	9.71152	0	0.07	0.10	1.02	1.02	0.18	0.23	0.87	0.94
15	2040	0.69368	0.69368	10.4052	10.4052	0	0.08	0.10	1.02	1.02	0.18	0.23	0.87	0.94
16	2041	0.69368	0.69368	11.09888	11.09888	0	0.08	0.11	1.02	1.02	0.18	0.23	0.88	0.95
17	2042	0.69368	0.69368	11.79256	11.79256	0	0.09	0.12	1.02	1.02	0.18	0.23	0.88	0.96
18	2043	0.69368	0.69368	12.48624	12.48624	0	0.09	0.12	1.02	1.02	0.18	0.23	0.89	0.96
19	2044	0.69368	0.69368	13.17992	13.17992	0	0.10	0.13	1.02	1.02	0.18	0.23	0.89	0.97
20	2045	0.69368	0.69368	13.8736	13.8736	0	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97
21	2046	0.69368	0.69368	14.56728	13.8736	0.69368	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97
22	2047	0.69368	0.69368	15.26096	13.8736	1.38736	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
23	2048	0.69368	0.69368	15.95464	13.8736	2.08104	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97
24	2049	0.69368	0.69368	16.64832	13.8736	2.77472	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97
25	2050	0.69368	0.69368	17.342	13.8736	3.4684	0.10	0.14	1.02	1.02	0.18	0.23	0.89	0.97
26	2051	0	0	17.342	13.17992	4.16208	0.10	0.13	1.02	1.02	0.00	0.00	1.12	1.15
27	2052	0	0	17.342	12.48624	4.85576	0.09	0.12	1.02	1.02	0.00	0.00	1.11	1.14
28	2053	0	0	17.342	11.79256	5.54944	0.09	0.12	1.02	1.02	0.00	0.00	1.11	1.14
29	2054	0	0	17.342	11.09888	6.24312	0.08	0.11	1.02	1.02	0.00	0.00	1.10	1.13
30	2055	0	0	17.342	10.4052	6.9368	0.08	0.10	1.02	1.02	0.00	0.00	1.10	1.13
31	2056	0	0	17.342	9.71152	7.63048	0.07	0.10	1.02	1.02	0.00	0.00	1.10	1.12
32	2057	0	0	17.342	9.01784	8.32416	0.07	0.09	1.03	1.03	0.00	0.00	1.09	1.12
33	2058	0	0	17.342	8.32416	9.01784	0.06	0.08	1.03	1.03	0.00	0.00	1.09	1.11
34	2059	0	0	17.342	7.63048	9.71152	0.06	0.08	1.03	1.03	0.00	0.00	1.09	1.10
35	2060	0	0	17.342	6.9368	10.4052	0.05	0.07	1.03	1.03	0.00	0.00	1.08	1.10
36	2061	0	0	17.342	6.24312	11.09888	0.05	0.06	1.03	1.03	0.00	0.00	1.08	1.09
37	2062	0	0	17.342	5.54944	11.79256	0.04	0.06	1.03	1.03	0.00	0.00	1.07	1.09
38	2063	0	0	17.342	4.85576	12.48624	0.04	0.05	1.03	1.03	0.00	0.00	1.07	1.08
39	2064	0	0	17.342	4.16208	13.17992	0.03	0.04	1.04	1.04	0.00	0.00	1.07	1.08
40	2065	0	0	17.342	3.4684	13.8736	0.03	0.03	1.04	1.04	0.00	0.00	1.06	1.07
41	2066	0	0	17.342	2.77472	14.56728	0.02	0.03	1.04	1.04	0.00	0.00	1.06	1.07
42	2067	0	0	17.342	2.08104	15.26096	0.02	0.02	1.04	1.04	0.00	0.00	1.05	1.06
43	2068	0	0	17.342	1.38736	15.95464	0.01	0.01	1.04	1.04	0.00	0.00	1.05	1.05
44	2069	0	0	17.342	0.69368	16.64832	0.01	0.01	1.04	1.04	0.00	0.00	1.05	1.05
45	2070	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04
46	2071	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04
47	2072	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04
48	2073	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04
49	2074	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
50	2075	0	0	17.342	0	17.342	0.00	0.00	1.04	1.04	0.00	0.00	1.04	1.04

Table 72: Annual Flux calculation under the reference scenario for Flanders

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
1	2026	0.22356	0.22356	0.22356	0.22356	0	0.00	0.00	0.82	1.27	0.04	0.07	0.75	1.24
2	2027	0.22356	0.22356	0.44712	0.44712	0	0.01	0.01	0.82	1.27	0.04	0.07	0.75	1.24
3	2028	0.22356	0.22356	0.67068	0.67068	0	0.01	0.01	0.82	1.27	0.04	0.07	0.76	1.24
4	2029	0.22356	0.22356	0.89424	0.89424	0	0.01	0.02	0.82	1.27	0.04	0.07	0.76	1.24
5	2030	0.22356	0.22356	1.1178	1.1178	0	0.01	0.02	0.82	1.27	0.04	0.07	0.76	1.24
6	2031	0.22356	0.22356	1.34136	1.34136	0	0.02	0.02	0.81	1.26	0.04	0.07	0.76	1.25
7	2032	0.22356	0.22356	1.56492	1.56492	0	0.02	0.03	0.81	1.26	0.04	0.07	0.76	1.25
8	2033	0.22356	0.22356	1.78848	1.78848	0	0.02	0.03	0.81	1.26	0.04	0.07	0.76	1.25
9	2034	0.22356	0.22356	2.01204	2.01204	0	0.02	0.03	0.81	1.26	0.04	0.07	0.77	1.25
10	2035	0.22356	0.22356	2.2356	2.2356	0	0.03	0.04	0.81	1.26	0.04	0.07	0.77	1.25
11	2036	0.22356	0.22356	2.45916	2.45916	0	0.03	0.04	0.81	1.26	0.04	0.07	0.77	1.26
12	2037	0.22356	0.22356	2.68272	2.68272	0	0.03	0.05	0.81	1.25	0.04	0.07	0.77	1.26
13	2038	0.22356	0.22356	2.90628	2.90628	0	0.04	0.05	0.81	1.25	0.04	0.07	0.77	1.26
14	2039	0.22356	0.22356	3.12984	3.12984	0	0.04	0.05	0.81	1.25	0.04	0.07	0.77	1.26
15	2040	0.22356	0.22356	3.3534	3.3534	0	0.04	0.06	0.80	1.25	0.04	0.07	0.78	1.27
16	2041	0.22356	0.22356	3.57696	3.57696	0	0.04	0.06	0.80	1.25	0.04	0.07	0.78	1.27
17	2042	0.22356	0.22356	3.80052	3.80052	0	0.05	0.06	0.80	1.25	0.04	0.07	0.78	1.27
18	2043	0.22356	0.22356	4.02408	4.02408	0	0.05	0.07	0.80	1.24	0.04	0.07	0.78	1.27
19	2044	0.22356	0.22356	4.24764	4.24764	0	0.05	0.07	0.80	1.24	0.04	0.07	0.78	1.27
20	2045	0.22356	0.22356	4.4712	4.4712	0	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28
21	2046	0.22356	0.22356	4.69476	4.4712	0.22356	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28
22	2047	0.22356	0.22356	4.91832	4.4712	0.44712	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
23	2048	0.22356	0.22356	5.14188	4.4712	0.67068	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28
24	2049	0.22356	0.22356	5.36544	4.4712	0.89424	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28
25	2050	0.22356	0.22356	5.589	4.4712	1.1178	0.05	0.08	0.80	1.24	0.04	0.07	0.78	1.28
26	2051	0	0	5.589	4.24764	1.34136	0.05	0.07	0.80	1.24	0.00	0.00	0.85	1.32
27	2052	0	0	5.589	4.02408	1.56492	0.05	0.07	0.80	1.24	0.00	0.00	0.85	1.31
28	2053	0	0	5.589	3.80052	1.78848	0.05	0.06	0.80	1.25	0.00	0.00	0.85	1.31
29	2054	0	0	5.589	3.57696	2.01204	0.04	0.06	0.80	1.25	0.00	0.00	0.85	1.31
30	2055	0	0	5.589	3.3534	2.2356	0.04	0.06	0.80	1.25	0.00	0.00	0.85	1.31
31	2056	0	0	5.589	3.12984	2.45916	0.04	0.05	0.81	1.25	0.00	0.00	0.84	1.30
32	2057	0	0	5.589	2.90628	2.68272	0.04	0.05	0.81	1.25	0.00	0.00	0.84	1.30
33	2058	0	0	5.589	2.68272	2.90628	0.03	0.05	0.81	1.25	0.00	0.00	0.84	1.30
34	2059	0	0	5.589	2.45916	3.12984	0.03	0.04	0.81	1.26	0.00	0.00	0.84	1.30
35	2060	0	0	5.589	2.2356	3.3534	0.03	0.04	0.81	1.26	0.00	0.00	0.84	1.30
36	2061	0	0	5.589	2.01204	3.57696	0.02	0.03	0.81	1.26	0.00	0.00	0.84	1.29
37	2062	0	0	5.589	1.78848	3.80052	0.02	0.03	0.81	1.26	0.00	0.00	0.83	1.29
38	2063	0	0	5.589	1.56492	4.02408	0.02	0.03	0.81	1.26	0.00	0.00	0.83	1.29
39	2064	0	0	5.589	1.34136	4.24764	0.02	0.02	0.81	1.26	0.00	0.00	0.83	1.29
40	2065	0	0	5.589	1.1178	4.4712	0.01	0.02	0.82	1.27	0.00	0.00	0.83	1.29
41	2066	0	0	5.589	0.89424	4.69476	0.01	0.02	0.82	1.27	0.00	0.00	0.83	1.28
42	2067	0	0	5.589	0.67068	4.91832	0.01	0.01	0.82	1.27	0.00	0.00	0.83	1.28
43	2068	0	0	5.589	0.44712	5.14188	0.01	0.01	0.82	1.27	0.00	0.00	0.82	1.28
44	2069	0	0	5.589	0.22356	5.36544	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.28
45	2070	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27
46	2071	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27
47	2072	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27
48	2073	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27
49	2074	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27
50	2075	0	0	5.589	0	5.589	0.00	0.00	0.82	1.27	0.00	0.00	0.82	1.27

Table 73: Annual Flux calculation under the reference scenario for Brussels

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
1	2026	0.00276	0.00276	0.00276	0.00276	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
2	2027	0.00276	0.00276	0.00552	0.00552	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
3	2028	0.00276	0.00276	0.00828	0.00828	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
4	2029	0.00276	0.00276	0.01104	0.01104	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
5	2030	0.00276	0.00276	0.0138	0.0138	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
6	2031	0.00276	0.00276	0.01656	0.01656	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
7	2032	0.00276	0.00276	0.01932	0.01932	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
8	2033	0.00276	0.00276	0.02208	0.02208	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
9	2034	0.00276	0.00276	0.02484	0.02484	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
10	2035	0.00276	0.00276	0.0276	0.0276	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
11	2036	0.00276	0.00276	0.03036	0.03036	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
12	2037	0.00276	0.00276	0.03312	0.03312	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
13	2038	0.00276	0.00276	0.03588	0.03588	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
14	2039	0.00276	0.00276	0.03864	0.03864	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
15	2040	0.00276	0.00276	0.0414	0.0414	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
16	2041	0.00276	0.00276	0.04416	0.04416	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
17	2042	0.00276	0.00276	0.04692	0.04692	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
18	2043	0.00276	0.00276	0.04968	0.04968	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
19	2044	0.00276	0.00276	0.05244	0.05244	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
20	2045	0.00276	0.00276	0.0552	0.0552	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
21	2046	0.00276	0.00276	0.05796	0.0552	0.00276	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
22	2047	0.00276	0.00276	0.06072	0.0552	0.00552	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
23	2048	0.00276	0.00276	0.06348	0.0552	0.00828	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
24	2049	0.00276	0.00276	0.06624	0.0552	0.01104	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
25	2050	0.00276	0.00276	0.069	0.0552	0.0138	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
26	2051	0	0	0.069	0.05244	0.01656	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
27	2052	0	0	0.069	0.04968	0.01932	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
28	2053	0	0	0.069	0.04692	0.02208	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
29	2054	0	0	0.069	0.04416	0.02484	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
30	2055	0	0	0.069	0.0414	0.0276	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
31	2056	0	0	0.069	0.03864	0.03036	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
32	2057	0	0	0.069	0.03588	0.03312	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
33	2058	0	0	0.069	0.03312	0.03588	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
34	2059	0	0	0.069	0.03036	0.03864	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
35	2060	0	0	0.069	0.0276	0.0414	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
36	2061	0	0	0.069	0.02484	0.04416	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
37	2062	0	0	0.069	0.02208	0.04692	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
38	2063	0	0	0.069	0.01932	0.04968	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
39	2064	0	0	0.069	0.01656	0.05244	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
40	2065	0	0	0.069	0.0138	0.0552	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
41	2066	0	0	0.069	0.01104	0.05796	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
42	2067	0	0	0.069	0.00828	0.06072	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
43	2068	0	0	0.069	0.00552	0.06348	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
44	2069	0	0	0.069	0.00276	0.06624	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
45	2070	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
46	2071	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
47	2072	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
48	2073	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
49	2074	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
50	2075	0	0	0.069	0	0.069	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02

Current policy scenario

Table 74: Annual Flux calculation under the current policy scenario for Wallonia

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
1	2026	0.69368	0.4524	0.4524	0.69368	0	0.01	0.01	1.04	1.04	0.12	0.15	0.9	0.93
2	2027	0.69368	0.4524	0.9048	1.38736	0	0.01	0.01	1.04	1.04	0.12	0.15	0.9	0.94
3	2028	0.69368	0.4524	1.3572	2.08104	0	0.02	0.02	1.04	1.04	0.12	0.15	0.91	0.94
4	2029	0.69368	0.4524	1.8096	2.77472	0	0.02	0.03	1.04	1.04	0.12	0.15	0.91	0.95
5	2030	0.69368	0.4524	2.262	3.4684	0	0.03	0.03	1.04	1.04	0.12	0.15	0.92	0.95
6	2031	0.69368	0.4524	2.7144	4.16208	0	0.03	0.04	1.04	1.04	0.12	0.15	0.92	0.96
7	2032	0.69368	0.4524	3.1668	4.85576	0	0.04	0.05	1.04	1.04	0.12	0.15	0.93	0.97
8	2033	0.69368	0.4524	3.6192	5.54944	0	0.04	0.06	1.04	1.04	0.12	0.15	0.93	0.97
9	2034	0.69368	0.4524	4.0716	6.24312	0	0.05	0.06	1.04	1.04	0.12	0.15	0.93	0.98
10	2035	0.69368	0.4524	4.524	6.9368	0	0.05	0.07	1.03	1.03	0.12	0.15	0.94	0.98
11	2036	0.69368	0.4524	4.9764	7.63048	0	0.06	0.08	1.03	1.03	0.12	0.15	0.94	0.99
12	2037	0.69368	0.4524	5.4288	8.32416	0	0.06	0.08	1.03	1.03	0.12	0.15	0.95	1
13	2038	0.69368	0.4524	5.8812	9.01784	0	0.07	0.09	1.03	1.03	0.12	0.15	0.95	1
14	2039	0.69368	0.4524	6.3336	9.71152	0	0.07	0.1	1.03	1.03	0.12	0.15	0.96	1.01
15	2040	0.69368	0.4524	6.786	10.4052	0	0.08	0.1	1.03	1.03	0.12	0.15	0.96	1.01
16	2041	0.69368	0.4524	7.2384	11.09888	0	0.08	0.11	1.03	1.03	0.12	0.15	0.96	1.02
17	2042	0.69368	0.4524	7.6908	11.79256	0	0.09	0.12	1.03	1.03	0.12	0.15	0.97	1.03
18	2043	0.69368	0.4524	8.1432	12.48624	0	0.09	0.12	1.03	1.03	0.12	0.15	0.97	1.03
19	2044	0.69368	0.4524	8.5956	13.17992	0	0.1	0.13	1.03	1.03	0.12	0.15	0.98	1.04
20	2045	0.69368	0.4524	9.048	13.8736	0	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.04
21	2046	0.69368	0.4524	9.5004	13.8736	0.69368	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.05
22	2047	0.69368	0.4524	9.9528	13.8736	1.38736	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.05
23	2048	0.69368	0.4524	10.4052	13.8736	2.08104	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.05
24	2049	0.69368	0.4524	10.8576	13.8736	2.77472	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.05
25	2050	0.69368	0.4524	11.31	13.8736	3.4684	0.1	0.14	1.03	1.03	0.12	0.15	0.98	1.05

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux-Min	Flux - Max
26	2051	0	0	11.31	13.17992	4.16208	0.1	0.13	1.03	1.03	0	0	1.13	1.16
27	2052	0	0	11.31	12.48624	4.85576	0.09	0.12	1.03	1.03	0	0	1.12	1.16
28	2053	0	0	11.31	11.79256	5.54944	0.09	0.12	1.03	1.03	0	0	1.12	1.15
29	2054	0	0	11.31	11.09888	6.24312	0.08	0.11	1.03	1.03	0	0	1.12	1.14
30	2055	0	0	11.31	10.4052	6.9368	0.08	0.1	1.03	1.03	0	0	1.11	1.14
31	2056	0	0	11.31	9.71152	7.63048	0.07	0.1	1.04	1.04	0	0	1.11	1.13
32	2057	0	0	11.31	9.01784	8.32416	0.07	0.09	1.04	1.04	0	0	1.11	1.13
33	2058	0	0	11.31	8.32416	9.01784	0.06	0.08	1.04	1.04	0	0	1.1	1.12
34	2059	0	0	11.31	7.63048	9.71152	0.06	0.08	1.04	1.04	0	0	1.1	1.12
35	2060	0	0	11.31	6.9368	10.4052	0.05	0.07	1.04	1.04	0	0	1.09	1.11
36	2061	0	0	11.31	6.24312	11.09888	0.05	0.06	1.04	1.04	0	0	1.09	1.11
37	2062	0	0	11.31	5.54944	11.79256	0.04	0.06	1.04	1.04	0	0	1.09	1.1
38	2063	0	0	11.31	4.85576	12.48624	0.04	0.05	1.05	1.05	0	0	1.08	1.09
39	2064	0	0	11.31	4.16208	13.17992	0.03	0.04	1.05	1.05	0	0	1.08	1.09
40	2065	0	0	11.31	3.4684	13.8736	0.03	0.03	1.05	1.05	0	0	1.07	1.08
41	2066	0	0	11.31	2.77472	14.56728	0.02	0.03	1.05	1.05	0	0	1.07	1.08
42	2067	0	0	11.31	2.08104	15.26096	0.02	0.02	1.05	1.05	0	0	1.07	1.07
43	2068	0	0	11.31	1.38736	15.95464	0.01	0.01	1.05	1.05	0	0	1.06	1.07
44	2069	0	0	11.31	0.69368	16.64832	0.01	0.01	1.05	1.05	0	0	1.06	1.06
45	2070	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06
46	2071	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06
47	2072	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06
48	2073	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06
49	2074	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06
50	2075	0	0	11.31	0	17.342	0	0	1.06	1.06	0	0	1.06	1.06

Table 75: Annual Flux calculation under the current policy scenario for Flanders

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	0.62356	0.1458	0.1458	0.62356	0	0.01	0.01	0.82	1.27	0.03	0.05	0.78	1.26
2	2027	0.62356	0.1458	0.2916	1.24712	0	0.02	0.02	0.82	1.27	0.03	0.05	0.79	1.27
3	2028	0.62356	0.1458	0.4374	1.87068	0	0.02	0.03	0.82	1.27	0.03	0.05	0.8	1.28
4	2029	0.62356	0.1458	0.5832	2.49424	0	0.03	0.04	0.82	1.27	0.03	0.05	0.8	1.29
5	2030	0.62356	0.1458	0.729	3.1178	0	0.04	0.05	0.82	1.27	0.03	0.05	0.81	1.29
6	2031	0.62356	0.1458	0.8748	3.74136	0	0.05	0.06	0.82	1.27	0.03	0.05	0.82	1.3
7	2032	0.62356	0.1458	1.0206	4.36492	0	0.05	0.07	0.82	1.27	0.03	0.05	0.82	1.31
8	2033	0.62356	0.1458	1.1664	4.98848	0	0.06	0.08	0.81	1.27	0.03	0.05	0.83	1.32
9	2034	0.62356	0.1458	1.3122	5.61204	0	0.07	0.1	0.81	1.26	0.03	0.05	0.84	1.33
10	2035	0.62356	0.1458	1.458	6.2356	0	0.08	0.11	0.81	1.26	0.03	0.05	0.84	1.34
11	2036	0.62356	0.1458	1.6038	6.85916	0	0.08	0.12	0.81	1.26	0.03	0.05	0.85	1.35
12	2037	0.62356	0.1458	1.7496	7.48272	0	0.09	0.13	0.81	1.26	0.03	0.05	0.86	1.36
13	2038	0.62356	0.1458	1.8954	8.10628	0	0.1	0.14	0.81	1.26	0.03	0.05	0.86	1.37
14	2039	0.62356	0.1458	2.0412	8.72984	0	0.11	0.15	0.81	1.26	0.03	0.05	0.87	1.38
15	2040	0.62356	0.1458	2.187	9.3534	0	0.11	0.16	0.81	1.26	0.03	0.05	0.88	1.39
16	2041	0.62356	0.1458	2.3328	9.97696	0	0.12	0.17	0.81	1.26	0.03	0.05	0.89	1.4
17	2042	0.62356	0.1458	2.4786	10.60052	0	0.13	0.18	0.81	1.26	0.03	0.05	0.89	1.41
18	2043	0.62356	0.1458	2.6244	11.22408	0	0.14	0.19	0.81	1.26	0.03	0.05	0.9	1.42
19	2044	0.62356	0.1458	2.7702	11.84764	0	0.14	0.2	0.81	1.25	0.03	0.05	0.91	1.43
20	2045	0.62356	0.1458	2.916	12.4712	0	0.15	0.21	0.81	1.25	0.03	0.05	0.91	1.44
21	2046	0.62356	0.1458	3.0618	12.4712	0.62356	0.15	0.21	0.81	1.26	0.03	0.05	0.92	1.44
22	2047	0.62356	0.1458	3.2076	12.4712	1.24712	0.15	0.21	0.81	1.26	0.03	0.05	0.92	1.44
23	2048	0.62356	0.1458	3.3534	12.4712	1.87068	0.15	0.21	0.81	1.26	0.03	0.05	0.92	1.45
24	2049	0.62356	0.1458	3.4992	12.4712	2.49424	0.15	0.21	0.82	1.27	0.03	0.05	0.92	1.45
25	2050	0.62356	0.1458	3.645	12.4712	3.1178	0.15	0.21	0.82	1.27	0.03	0.05	0.92	1.46
26	2051	0	0	3.645	11.84764	3.74136	0.14	0.2	0.82	1.28	0	0	0.97	1.48
27	2052	0	0	3.645	11.22408	4.36492	0.14	0.19	0.82	1.28	0	0	0.96	1.47

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
28	2053	0	0	3.645	10.60052	4.98848	0.13	0.18	0.83	1.28	0	0	0.96	1.46
29	2054	0	0	3.645	9.97696	5.61204	0.12	0.17	0.83	1.29	0	0	0.95	1.46
30	2055	0	0	3.645	9.3534	6.2356	0.11	0.16	0.83	1.29	0	0	0.95	1.45
31	2056	0	0	3.645	8.72984	6.85916	0.11	0.15	0.84	1.3	0	0	0.94	1.45
32	2057	0	0	3.645	8.10628	7.48272	0.1	0.14	0.84	1.3	0	0	0.94	1.44
33	2058	0	0	3.645	7.48272	8.10628	0.09	0.13	0.84	1.31	0	0	0.93	1.43
34	2059	0	0	3.645	6.85916	8.72984	0.08	0.12	0.84	1.31	0	0	0.93	1.43
35	2060	0	0	3.645	6.2356	9.3534	0.08	0.11	0.85	1.32	0	0	0.92	1.42
36	2061	0	0	3.645	5.61204	9.97696	0.07	0.1	0.85	1.32	0	0	0.92	1.42
37	2062	0	0	3.645	4.98848	10.60052	0.06	0.08	0.85	1.33	0	0	0.91	1.41
38	2063	0	0	3.645	4.36492	11.22408	0.05	0.07	0.86	1.33	0	0	0.91	1.4
39	2064	0	0	3.645	3.74136	11.84764	0.05	0.06	0.86	1.34	0	0	0.91	1.4
40	2065	0	0	3.645	3.1178	12.4712	0.04	0.05	0.86	1.34	0	0	0.9	1.39
41	2066	0	0	3.645	2.49424	13.09476	0.03	0.04	0.87	1.34	0	0	0.9	1.39
42	2067	0	0	3.645	1.87068	13.71832	0.02	0.03	0.87	1.35	0	0	0.89	1.38
43	2068	0	0	3.645	1.24712	14.34188	0.02	0.02	0.87	1.35	0	0	0.89	1.37
44	2069	0	0	3.645	0.62356	14.96544	0.01	0.01	0.87	1.36	0	0	0.88	1.37
45	2070	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36
46	2071	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36
47	2072	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36
48	2073	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36
49	2074	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36
50	2075	0	0	3.645	0	15.589	0	0	0.88	1.36	0	0	0.88	1.36

Table 76: Annual Flux calculation under the current policy scenario for Brussels

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	0.00276	0.0018	0.0018	0.00276	0	0	0	0.02	0.02	0	0	0.02	0.02
2	2027	0.00276	0.0018	0.0036	0.00552	0	0	0	0.02	0.02	0	0	0.02	0.02
3	2028	0.00276	0.0018	0.0054	0.00828	0	0	0	0.02	0.02	0	0	0.02	0.02
4	2029	0.00276	0.0018	0.0072	0.01104	0	0	0	0.02	0.02	0	0	0.02	0.02
5	2030	0.00276	0.0018	0.009	0.0138	0	0	0	0.02	0.02	0	0	0.02	0.02
6	2031	0.00276	0.0018	0.0108	0.01656	0	0	0	0.02	0.02	0	0	0.02	0.02
7	2032	0.00276	0.0018	0.0126	0.01932	0	0	0	0.02	0.02	0	0	0.02	0.02
8	2033	0.00276	0.0018	0.0144	0.02208	0	0	0	0.02	0.02	0	0	0.02	0.02
9	2034	0.00276	0.0018	0.0162	0.02484	0	0	0	0.02	0.02	0	0	0.02	0.02
10	2035	0.00276	0.0018	0.018	0.0276	0	0	0	0.02	0.02	0	0	0.02	0.02
11	2036	0.00276	0.0018	0.0198	0.03036	0	0	0	0.02	0.02	0	0	0.02	0.02
12	2037	0.00276	0.0018	0.0216	0.03312	0	0	0	0.02	0.02	0	0	0.02	0.02
13	2038	0.00276	0.0018	0.0234	0.03588	0	0	0	0.02	0.02	0	0	0.02	0.02
14	2039	0.00276	0.0018	0.0252	0.03864	0	0	0	0.02	0.02	0	0	0.02	0.02
15	2040	0.00276	0.0018	0.027	0.0414	0	0	0	0.02	0.02	0	0	0.02	0.02
16	2041	0.00276	0.0018	0.0288	0.04416	0	0	0	0.02	0.02	0	0	0.02	0.02
17	2042	0.00276	0.0018	0.0306	0.04692	0	0	0	0.02	0.02	0	0	0.02	0.02
18	2043	0.00276	0.0018	0.0324	0.04968	0	0	0	0.02	0.02	0	0	0.02	0.02
19	2044	0.00276	0.0018	0.0342	0.05244	0	0	0	0.02	0.02	0	0	0.02	0.02
20	2045	0.00276	0.0018	0.036	0.0552	0	0	0	0.02	0.02	0	0	0.02	0.02
21	2046	0.00276	0.0018	0.0378	0.0552	0.00276	0	0	0.02	0.02	0	0	0.02	0.02
22	2047	0.00276	0.0018	0.0396	0.0552	0.00552	0	0	0.02	0.02	0	0	0.02	0.02
23	2048	0.00276	0.0018	0.0414	0.0552	0.00828	0	0	0.02	0.02	0	0	0.02	0.02
24	2049	0.00276	0.0018	0.0432	0.0552	0.01104	0	0	0.02	0.02	0	0	0.02	0.02
25	2050	0.00276	0.0018	0.045	0.0552	0.0138	0	0	0.02	0.02	0	0	0.02	0.02
26	2051	0	0	0.045	0.05244	0.01656	0	0	0.02	0.02	0	0	0.02	0.02
27	2052	0	0	0.045	0.04968	0.01932	0	0	0.02	0.02	0	0	0.02	0.02

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
28	2053	0	0	0.045	0.04692	0.02208	0	0	0.02	0.02	0	0	0.02	0.02
29	2054	0	0	0.045	0.04416	0.02484	0	0	0.02	0.02	0	0	0.02	0.02
30	2055	0	0	0.045	0.0414	0.0276	0	0	0.02	0.02	0	0	0.02	0.02
31	2056	0	0	0.045	0.03864	0.03036	0	0	0.02	0.02	0	0	0.02	0.02
32	2057	0	0	0.045	0.03588	0.03312	0	0	0.02	0.02	0	0	0.02	0.02
33	2058	0	0	0.045	0.03312	0.03588	0	0	0.02	0.02	0	0	0.02	0.02
34	2059	0	0	0.045	0.03036	0.03864	0	0	0.02	0.02	0	0	0.02	0.02
35	2060	0	0	0.045	0.0276	0.0414	0	0	0.02	0.02	0	0	0.02	0.02
36	2061	0	0	0.045	0.02484	0.04416	0	0	0.02	0.02	0	0	0.02	0.02
37	2062	0	0	0.045	0.02208	0.04692	0	0	0.02	0.02	0	0	0.02	0.02
38	2063	0	0	0.045	0.01932	0.04968	0	0	0.02	0.02	0	0	0.02	0.02
39	2064	0	0	0.045	0.01656	0.05244	0	0	0.02	0.02	0	0	0.02	0.02
40	2065	0	0	0.045	0.0138	0.0552	0	0	0.02	0.02	0	0	0.02	0.02
41	2066	0	0	0.045	0.01104	0.05796	0	0	0.02	0.02	0	0	0.02	0.02
42	2067	0	0	0.045	0.00828	0.06072	0	0	0.02	0.02	0	0	0.02	0.02
43	2068	0	0	0.045	0.00552	0.06348	0	0	0.02	0.02	0	0	0.02	0.02
44	2069	0	0	0.045	0.00276	0.06624	0	0	0.02	0.02	0	0	0.02	0.02
45	2070	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02
46	2071	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02
47	2072	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02
48	2073	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02
49	2074	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02
50	2075	0	0	0.045	0	0.069	0	0	0.02	0.02	0	0	0.02	0.02

Major Change scenario

Table 77: Annual Flux calculation under the major change scenario for Wallonia

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	2.4128	0	0	2.4128	0	0.02	0.02	1.04	1.04	0.00	0.00	1.06	1.07
2	2027	2.4128	0	0	4.8256	0	0.04	0.05	1.04	1.04	0.00	0.00	1.08	1.09
3	2028	2.4128	0	0	7.2384	0	0.05	0.07	1.04	1.04	0.00	0.00	1.10	1.12
4	2029	2.4128	0	0	9.6512	0	0.07	0.10	1.04	1.04	0.00	0.00	1.12	1.14
5	2030	2.4128	0	0	12.064	0	0.09	0.12	1.04	1.04	0.00	0.00	1.13	1.16
6	2031	2.4128	0	0	14.4768	0	0.11	0.14	1.04	1.04	0.00	0.00	1.15	1.19
7	2032	2.4128	0	0	16.8896	0	0.13	0.17	1.04	1.04	0.00	0.00	1.17	1.21
8	2033	2.4128	0	0	19.3024	0	0.14	0.19	1.04	1.04	0.00	0.00	1.19	1.24
9	2034	2.4128	0	0	21.7152	0	0.16	0.22	1.04	1.04	0.00	0.00	1.21	1.26
10	2035	2.4128	0	0	24.128	0	0.18	0.24	1.04	1.04	0.00	0.00	1.22	1.28
11	2036	2.4128	0	0	26.5408	0	0.20	0.27	1.04	1.04	0.00	0.00	1.24	1.31
12	2037	2.4128	0	0	28.9536	0	0.22	0.29	1.04	1.04	0.00	0.00	1.26	1.33
13	2038	2.4128	0	0	31.3664	0	0.24	0.31	1.04	1.04	0.00	0.00	1.28	1.36
14	2039	2.4128	0	0	33.7792	0	0.25	0.34	1.04	1.04	0.00	0.00	1.30	1.38
15	2040	2.4128	0	0	36.192	0	0.27	0.36	1.04	1.04	0.00	0.00	1.31	1.41
16	2041	2.4128	0	0	38.6048	0	0.29	0.39	1.04	1.04	0.00	0.00	1.33	1.43
17	2042	2.4128	0	0	41.0176	0	0.31	0.41	1.04	1.04	0.00	0.00	1.35	1.45
18	2043	2.4128	0	0	43.4304	0	0.33	0.43	1.04	1.04	0.00	0.00	1.37	1.48
19	2044	2.4128	0	0	45.8432	0	0.34	0.46	1.04	1.04	0.00	0.00	1.39	1.50
20	2045	2.4128	0	0	48.256	0	0.36	0.48	1.04	1.04	0.00	0.00	1.40	1.53
21	2046	2.4128	0	0	48.256	2.4128	0.36	0.48	1.05	1.05	0.00	0.00	1.41	1.53
22	2047	2.4128	0	0	48.256	4.8256	0.36	0.48	1.05	1.05	0.00	0.00	1.41	1.54
23	2048	2.4128	0	0	48.256	7.2384	0.36	0.48	1.06	1.06	0.00	0.00	1.42	1.54
24	2049	2.4128	0	0	48.256	9.6512	0.36	0.48	1.06	1.06	0.00	0.00	1.42	1.54
25	2050	2.4128	0	0	48.256	12.064	0.36	0.48	1.07	1.07	0.00	0.00	1.43	1.55

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
26	2051	0	0	0	45.8432	14.4768	0.34	0.46	1.07	1.07	0.00	0.00	1.42	1.53
27	2052	0	0	0	43.4304	16.8896	0.33	0.43	1.08	1.08	0.00	0.00	1.40	1.51
28	2053	0	0	0	41.0176	19.3024	0.31	0.41	1.08	1.08	0.00	0.00	1.39	1.49
29	2054	0	0	0	38.6048	21.7152	0.29	0.39	1.09	1.09	0.00	0.00	1.37	1.47
30	2055	0	0	0	36.192	24.128	0.27	0.36	1.09	1.09	0.00	0.00	1.36	1.45
31	2056	0	0	0	33.7792	26.5408	0.25	0.34	1.10	1.10	0.00	0.00	1.35	1.43
32	2057	0	0	0	31.3664	28.9536	0.24	0.31	1.10	1.10	0.00	0.00	1.33	1.41
33	2058	0	0	0	28.9536	31.3664	0.22	0.29	1.10	1.10	0.00	0.00	1.32	1.39
34	2059	0	0	0	26.5408	33.7792	0.20	0.27	1.11	1.11	0.00	0.00	1.31	1.37
35	2060	0	0	0	24.128	36.192	0.18	0.24	1.11	1.11	0.00	0.00	1.29	1.36
36	2061	0	0	0	21.7152	38.6048	0.16	0.22	1.12	1.12	0.00	0.00	1.28	1.34
37	2062	0	0	0	19.3024	41.0176	0.14	0.19	1.12	1.12	0.00	0.00	1.27	1.32
38	2063	0	0	0	16.8896	43.4304	0.13	0.17	1.13	1.13	0.00	0.00	1.25	1.30
39	2064	0	0	0	14.4768	45.8432	0.11	0.14	1.13	1.13	0.00	0.00	1.24	1.28
40	2065	0	0	0	12.064	48.256	0.09	0.12	1.14	1.14	0.00	0.00	1.23	1.26
41	2066	0	0	0	9.6512	50.6688	0.07	0.10	1.14	1.14	0.00	0.00	1.21	1.24
42	2067	0	0	0	7.2384	53.0816	0.05	0.07	1.15	1.15	0.00	0.00	1.20	1.22
43	2068	0	0	0	4.8256	55.4944	0.04	0.05	1.15	1.15	0.00	0.00	1.19	1.20
44	2069	0	0	0	2.4128	57.9072	0.02	0.02	1.16	1.16	0.00	0.00	1.17	1.18
45	2070	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16
46	2071	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16
47	2072	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16
48	2073	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16
49	2074	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16
50	2075	0	0	0	0	60.32	0.00	0.00	1.16	1.16	0.00	0.00	1.16	1.16

Table 78: Annual Flux calculation under the major change scenario for Flanders

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	0.7776	0	0	0.7776	0	0.01	0.01	0.82	1.27	0.00	0.00	0.83	1.29
2	2027	0.7776	0	0	1.5552	0	0.02	0.03	0.82	1.27	0.00	0.00	0.84	1.30
3	2028	0.7776	0	0	2.3328	0	0.03	0.04	0.82	1.27	0.00	0.00	0.85	1.31
4	2029	0.7776	0	0	3.1104	0	0.04	0.05	0.82	1.27	0.00	0.00	0.86	1.33
5	2030	0.7776	0	0	3.888	0	0.05	0.07	0.82	1.27	0.00	0.00	0.87	1.34
6	2031	0.7776	0	0	4.6656	0	0.06	0.08	0.82	1.27	0.00	0.00	0.88	1.35
7	2032	0.7776	0	0	5.4432	0	0.07	0.09	0.82	1.27	0.00	0.00	0.89	1.37
8	2033	0.7776	0	0	6.2208	0	0.08	0.11	0.82	1.27	0.00	0.00	0.90	1.38
9	2034	0.7776	0	0	6.9984	0	0.09	0.12	0.82	1.27	0.00	0.00	0.91	1.39
10	2035	0.7776	0	0	7.776	0	0.09	0.13	0.82	1.27	0.00	0.00	0.92	1.41
11	2036	0.7776	0	0	8.5536	0	0.10	0.15	0.82	1.27	0.00	0.00	0.92	1.42
12	2037	0.7776	0	0	9.3312	0	0.11	0.16	0.82	1.27	0.00	0.00	0.93	1.43
13	2038	0.7776	0	0	10.1088	0	0.12	0.17	0.82	1.27	0.00	0.00	0.94	1.45
14	2039	0.7776	0	0	10.8864	0	0.13	0.19	0.82	1.27	0.00	0.00	0.95	1.46
15	2040	0.7776	0	0	11.664	0	0.14	0.20	0.82	1.27	0.00	0.00	0.96	1.47
16	2041	0.7776	0	0	12.4416	0	0.15	0.21	0.82	1.27	0.00	0.00	0.97	1.49
17	2042	0.7776	0	0	13.2192	0	0.16	0.22	0.82	1.27	0.00	0.00	0.98	1.50
18	2043	0.7776	0	0	13.9968	0	0.17	0.24	0.82	1.27	0.00	0.00	0.99	1.51
19	2044	0.7776	0	0	14.7744	0	0.18	0.25	0.82	1.27	0.00	0.00	1.00	1.53
20	2045	0.7776	0	0	15.552	0	0.19	0.26	0.82	1.27	0.00	0.00	1.01	1.54
21	2046	0.7776	0	0	15.552	0.7776	0.19	0.26	0.82	1.28	0.00	0.00	1.01	1.54
22	2047	0.7776	0	0	15.552	1.5552	0.19	0.26	0.83	1.29	0.00	0.00	1.02	1.55
23	2048	0.7776	0	0	15.552	2.3328	0.19	0.26	0.83	1.29	0.00	0.00	1.02	1.56
24	2049	0.7776	0	0	15.552	3.1104	0.19	0.26	0.84	1.30	0.00	0.00	1.03	1.56
25	2050	0.7776	0	0	15.552	3.888	0.19	0.26	0.84	1.30	0.00	0.00	1.03	1.57
26	2051	0	0	0	14.7744	4.6656	0.18	0.25	0.84	1.31	0.00	0.00	1.02	1.56
27	2052	0	0	0	13.9968	5.4432	0.17	0.24	0.85	1.31	0.00	0.00	1.02	1.55

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
28	2053	0	0	0	13.2192	6.2208	0.16	0.22	0.85	1.32	0.00	0.00	1.01	1.55
29	2054	0	0	0	12.4416	6.9984	0.15	0.21	0.85	1.33	0.00	0.00	1.01	1.54
30	2055	0	0	0	11.664	7.776	0.14	0.20	0.86	1.33	0.00	0.00	1.00	1.53
31	2056	0	0	0	10.8864	8.5536	0.13	0.19	0.86	1.34	0.00	0.00	0.99	1.52
32	2057	0	0	0	10.1088	9.3312	0.12	0.17	0.86	1.34	0.00	0.00	0.99	1.52
33	2058	0	0	0	9.3312	10.1088	0.11	0.16	0.87	1.35	0.00	0.00	0.98	1.51
34	2059	0	0	0	8.5536	10.8864	0.10	0.15	0.87	1.36	0.00	0.00	0.98	1.50
35	2060	0	0	0	7.776	11.664	0.09	0.13	0.88	1.36	0.00	0.00	0.97	1.49
36	2061	0	0	0	6.9984	12.4416	0.09	0.12	0.88	1.37	0.00	0.00	0.97	1.49
37	2062	0	0	0	6.2208	13.2192	0.08	0.11	0.88	1.37	0.00	0.00	0.96	1.48
38	2063	0	0	0	5.4432	13.9968	0.07	0.09	0.89	1.38	0.00	0.00	0.95	1.47
39	2064	0	0	0	4.6656	14.7744	0.06	0.08	0.89	1.38	0.00	0.00	0.95	1.46
40	2065	0	0	0	3.888	15.552	0.05	0.07	0.89	1.39	0.00	0.00	0.94	1.46
41	2066	0	0	0	3.1104	16.3296	0.04	0.05	0.90	1.40	0.00	0.00	0.94	1.45
42	2067	0	0	0	2.3328	17.1072	0.03	0.04	0.90	1.40	0.00	0.00	0.93	1.44
43	2068	0	0	0	1.5552	17.8848	0.02	0.03	0.91	1.41	0.00	0.00	0.92	1.43
44	2069	0	0	0	0.7776	18.6624	0.01	0.01	0.91	1.41	0.00	0.00	0.92	1.43
45	2070	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42
46	2071	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42
47	2072	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42
48	2073	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42
49	2074	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42
50	2075	0	0	0	0	19.44	0.00	0.00	0.91	1.42	0.00	0.00	0.91	1.42

Table 79: Annual Flux calculation under the major change scenario for Brussels

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
1	2026	0.0096	0	0	0.0096	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
2	2027	0.0096	0	0	0.0192	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
3	2028	0.0096	0	0	0.0288	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
4	2029	0.0096	0	0	0.0384	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
5	2030	0.0096	0	0	0.048	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
6	2031	0.0096	0	0	0.0576	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
7	2032	0.0096	0	0	0.0672	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
8	2033	0.0096	0	0	0.0768	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
9	2034	0.0096	0	0	0.0864	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
10	2035	0.0096	0	0	0.096	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
11	2036	0.0096	0	0	0.1056	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
12	2037	0.0096	0	0	0.1152	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
13	2038	0.0096	0	0	0.1248	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
14	2039	0.0096	0	0	0.1344	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
15	2040	0.0096	0	0	0.144	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
16	2041	0.0096	0	0	0.1536	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
17	2042	0.0096	0	0	0.1632	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
18	2043	0.0096	0	0	0.1728	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
19	2044	0.0096	0	0	0.1824	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
20	2045	0.0096	0	0	0.192	0	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
21	2046	0.0096	0	0	0.192	0.0096	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
22	2047	0.0096	0	0	0.192	0.0192	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
23	2048	0.0096	0	0	0.192	0.0288	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
24	2049	0.0096	0	0	0.192	0.0384	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
25	2050	0.0096	0	0	0.192	0.048	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
26	2051	0	0	0	0.1824	0.0576	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
27	2052	0	0	0	0.1728	0.0672	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02

Year	Date	Afforestation	Deforestation	Deforestation Cumul.	Area Juvenile	Area Mature	Absorption Juvenile - Min	Absorption Juvenile - Max	Absorption Mature - Min	Absorption Mature - Max	Emission - Min	Emission - Max	Flux- Min	Flux - Max
28	2053	0	0	0	0.1632	0.0768	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
29	2054	0	0	0	0.1536	0.0864	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
30	2055	0	0	0	0.144	0.096	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
31	2056	0	0	0	0.1344	0.1056	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
32	2057	0	0	0	0.1248	0.1152	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
33	2058	0	0	0	0.1152	0.1248	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
34	2059	0	0	0	0.1056	0.1344	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
35	2060	0	0	0	0.096	0.144	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
36	2061	0	0	0	0.0864	0.1536	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
37	2062	0	0	0	0.0768	0.1632	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
38	2063	0	0	0	0.0672	0.1728	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
39	2064	0	0	0	0.0576	0.1824	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
40	2065	0	0	0	0.048	0.192	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
41	2066	0	0	0	0.0384	0.2016	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
42	2067	0	0	0	0.0288	0.2112	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
43	2068	0	0	0	0.0192	0.2208	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
44	2069	0	0	0	0.0096	0.2304	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
45	2070	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
46	2071	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
47	2072	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
48	2073	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
49	2074	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02
50	2075	0	0	0	0	0.24	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.02

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Table 80: Minimum and Maximum Sequestration Values for each Scenario

Year	Date	Reference Scenario – Minimum Value	Reference Scenario – Maximum Value	Current policy Scenario – Minimum Value	Current policy Scenario – Maximum Value	Major Change Scenario – Minimum Value	Major Change Scenario – Maximum Value
1	2026	1.59	2.12	1.70	2.21	1.91	2.37
2	2027	1.60	2.13	1.71	2.22	1.94	2.41
3	2028	1.60	2.13	1.72	2.24	1.97	2.45
4	2029	1.61	2.14	1.73	2.25	1.99	2.49
5	2030	1.61	2.15	1.75	2.27	2.02	2.52
6	2031	1.62	2.16	1.76	2.28	2.05	2.56
7	2032	1.62	2.17	1.77	2.30	2.08	2.60
8	2033	1.63	2.17	1.78	2.31	2.10	2.64
9	2034	1.64	2.18	1.79	2.33	2.13	2.67
10	2035	1.64	2.19	1.80	2.35	2.16	2.71
11	2036	1.65	2.20	1.81	2.36	2.19	2.75
12	2037	1.65	2.20	1.82	2.38	2.22	2.79
13	2038	1.66	2.21	1.84	2.39	2.24	2.82
14	2039	1.66	2.22	1.85	2.41	2.27	2.86
15	2040	1.67	2.23	1.86	2.42	2.30	2.90
16	2041	1.67	2.24	1.87	2.44	2.33	2.94
17	2042	1.68	2.24	1.88	2.46	2.35	2.97
18	2043	1.68	2.25	1.89	2.47	2.38	3.01
19	2044	1.69	2.26	1.90	2.49	2.41	3.05
20	2045	1.70	2.27	1.91	2.50	2.44	3.09
21	2046	1.70	2.27	1.92	2.51	2.45	3.10
22	2047	1.70	2.27	1.92	2.51	2.45	3.11
23	2048	1.70	2.27	1.92	2.51	2.46	3.12
24	2049	1.70	2.27	1.93	2.52	2.47	3.13
25	2050	1.70	2.27	1.93	2.52	2.48	3.14

Year	Date	Reference Scenario – Minimum Value	Reference Scenario – Maximum Value	Current policy Scenario – Minimum Value	Current policy Scenario – Maximum Value	Major Change Scenario – Minimum Value	Major Change Scenario – Maximum Value
26	2051	1.99	2.48	2.11	2.66	2.46	3.11
27	2052	1.98	2.48	2.11	2.65	2.44	3.09
28	2053	1.98	2.47	2.10	2.63	2.42	3.06
29	2054	1.97	2.46	2.09	2.62	2.40	3.03
30	2055	1.97	2.45	2.08	2.61	2.38	3.01
31	2056	1.96	2.45	2.07	2.60	2.36	2.98
32	2057	1.95	2.44	2.06	2.59	2.35	2.95
33	2058	1.95	2.43	2.05	2.58	2.33	2.92
34	2059	1.94	2.42	2.05	2.57	2.31	2.90
35	2060	1.94	2.41	2.04	2.55	2.29	2.87
36	2061	1.93	2.41	2.03	2.54	2.27	2.84
37	2062	1.93	2.40	2.02	2.53	2.25	2.82
38	2063	1.92	2.39	2.01	2.52	2.23	2.79
39	2064	1.92	2.38	2.00	2.51	2.21	2.76
40	2065	1.91	2.38	1.99	2.50	2.19	2.74
41	2066	1.91	2.37	1.99	2.48	2.17	2.71
42	2067	1.90	2.36	1.98	2.47	2.15	2.68
43	2068	1.89	2.35	1.97	2.46	2.13	2.66
44	2069	1.89	2.35	1.96	2.45	2.12	2.63
45	2070	1.88	2.34	1.95	2.44	2.10	2.60
46	2071	1.88	2.34	1.95	2.44	2.10	2.60
47	2072	1.88	2.34	1.95	2.44	2.10	2.60
48	2073	1.88	2.34	1.95	2.44	2.10	2.60
49	2074	1.88	2.34	1.95	2.44	2.10	2.60
50	2075	1.88	2.34	1.95	2.44	2.10	2.60
	TOTAL 2050	**41.35**	**55.19**	**45.76**	**59.65**	**55.79**	**70.22**
	AVERAGE 2050	**1.65**	**2.21**	**1.83**	**2.39**	**2.23**	**2.81**

ANNEX 6: ESTIMATE OF EMISSIONS FROM SETTLEMENT AREA

In addition to emissions and removals within agricultural land, forests and wetlands, conversion to settlement area was also included in Table 64. Emissions from mineral soils associated with settlement expansion were estimated analogue to the methodology proposed in the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024). Emission factors were derived from the NIR (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024) and differentiated by land-use category and region. For Flanders, mineral soil carbon stocks were assumed to be 90 t C/ha for forest land, 74 t C/ha for grassland, and 54 t C/ha for cropland and settlement area. Corresponding values for Wallonia were 110 t C/ha for forest land, 90 t C/ha for grassland, and 51 t C/ha for cropland and settlement area. It was assumed that 60% of settlement expansion occurs in Flanders and 40% in Wallonia. Carbon stock changes in mineral soil were assumed to occur over a 20-year transition period. The yearly estimated emissions from the conversions in each scenario are provided in Table 64. To estimate emissions for the current situation, activity data were taken from the NIR, resulting in an estimated emission of approx. 315 kt CO_2eq/yr (CELINE-IRCEL, Federal Public Service for Health, Food Chain Safety and the Environment, National Climate Commission, 2024).

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