EcoTree CO_2 Quantification Methodology

EcoTree is a company specialising in the ecological and economic development and renewal of forests. EcoTree gives individuals and companies the opportunity to invest in the creation and maintenance of forest stands by becoming the owner of trees on properties whose land is held by EcoTree or third parties. By becoming an owner, our customers support biodiversity, sustainable forest management, the forest's many natural functions and receive income from it. All forest management is carried out by EcoTree teams with a silvicultural approach known as "close to nature". With this mindset, EcoTree seeks to enhance all of the forest's multifunctionalities, including carbon storage. In 2019, EcoTree developed a first version of a tool which, based on the forestry management plans (a), allowed them to quantify the carbon stored by our forests (b). This method is constantly being improved, e.g. to take into account wood products and their substitution effects, to ensure the permanence clause, etc. This method has been verified by Bureau Veritas for its applicability to EcoTree's afforestation projects.

Key words: *carbon sequestration, carbon storage in wood products, substitution, Label Bas Carbone, irregular sylviculture, LTAS*

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1. Introduction

1.1 Forestry management plans

EcoTree first worked with several forest experts and independent forest engineers to outline typical cases of forestry management plans. These plans are adaptations and revisions of reference production tables, which, faced today with the reality of the field, climate change, and the sustainable forestry methods favoured by EcoTree, may have seemed, in several respects, obsolete, often too optimistic or unsuitable.

EcoTree has developed 28 theoretical and standardised forestry management plans for:

- Different species (14)
- Different fertility classes (3)
- Different types of management (14 x 3 irregular, 14 x 3 regular)

Given the unique nature of each forest, EcoTree then reworks the typical plan most suited to each situation and submits it for validation by a forestry expert who certifies, based on a certain number of criteria, its consistency.

The Label Bas Carbone (French for "Low Carbon Label", LBC) method uses a polynomial equation to determine the volume over time. However, the new forestry management plans on which this method is based provide the necessary data year by year, obtained with the CAPSIS software developed by CIRAD (Website in references, see 15).

1.2 Carbon storage

EcoTree therefore worked on a tool to quantify each stand's expected carbon storage, on the basis of the forestry management plan chosen. EcoTree customers, owners of trees in these areas, can thus see the benefits of good forest management, in terms of carbon storage.

This quantification tool is inspired by the methods of the LBC (Ministry of Ecological Transition). Strictly speaking, however, its intent is not to commercialise carbon credits, and it therefore separates itself from the voluntary carbon offset market and its eligibility criteria:

- EcoTree doesn't discount the stored carbon, the tree owner is aware of the various natural hazards that can impact carbon storage, as well as its revenues over the operating horizon,

- EcoTree does not limit carbon quantification to 30 years, instead quantifying the carbon stored throughout the life of the stands it manages, projects are calculated over 100 years for the relevant metrics,

- Carbon quantification is based on the quantification equations of the Label Bas Carbone (LBC) Version 2 of 07/27/2020, modified.

2. Glossary

2.1 Forestry management plans, common forestry terms

Cutting cycle: time between two successive cuts of the same type in the same plot. Ex: 12-year cycle for thinning deciduous trees. (Silvicultural glossary)

Rotation: time it takes for a stand to renew itself between two clear cuts or successive regenerations.

Dominant height: average total height of the hundred largest trees per hectare in a stand.

Basal area: A measurement used to help estimate forest stocking: the sum of the stems' cross-sectional areas 1.3m above the ground. It is therefore expressed in m2/ha.

Timber volume: a tree's wood volume for a cutting diameter, down to 7 cm.

Litter: The uppermost layer of the soil, composed of freshly fallen or slightly decomposed organic matter and debris. It hosts an ecosystem of decomposing organisms which gradually transforms it into humus (Source: futura-sciences).

Humus: upper layer of the soil created and maintained by the decomposition of organic matter, mainly by the combined action of animals, bacteria and fungi in the soil; it is dark in color because it contains a lot of carbon (Source: actu-environnement).

Productivity: increase in the volume of woody material (in m^3/ha/year).

2.2 Carbon calculation

The 3 S:

- Sequestration (in biomass): trapping CO_2 in biomass through photosynthesis.
- Storage (in products): storage of CO_2 in wood industry products (furniture, crates, beams, shavings, etc.).
- Substitution: see paragraph on products/sector 2.4 (and see 7 for exact coefficients).

Biomass: mass or total amount of organic matter from organisms living in a particular area at a given time.

- Biomass of a tree: aboveground biomass + root biomass.
- Above ground biomass: includes the trunk and crown.
- Root biomass: includes the root system in the ground.

Infradensity: ratio between the mass of dry wood and the volume of green wood = dry mass contained in the wet volume.

tDS: tonne of dry mass, this is the metric used to calculate the volume before going into carbon assessment (carbon rate = 0.475 tC/tDS) then carbon dioxide equivalent.

Carbon vs Carbon Dioxide (C/CO_2): Some documents use carbon rather than carbon dioxide as a value. The fraction of carbon in carbon dioxide is the ratio of their weights. The atomic weight of carbon is 12 atomic mass units, while the weight of carbon dioxide is 44, since it includes two oxygen atoms that each weigh 16. So, to switch from one to the other, we must use the formula: One tonne of carbon is equivalent to 44/12 (tCO_2/tC) = 3.67 tonnes of carbon dioxide. Thus, 11 tonnes of carbon dioxide equals 3 tonnes of carbon.

Additional carbon (or additionality): quantity of carbon produced within the framework of the project (population, products and to a lesser extent substitution). The quantities of carbon in the soil and in the litter are not taken into account, except in the case of a conversion of agricultural land where the project improves the carbon storage capacity of the soil.

2.3 Labelling (LBC, 2020)

Reference scenario: assumptions making it possible to determine the state of a plot (soil and stand) in the event that the project does not take place and that there is no modification of use. There are three cases: clearing, afforestation and reconstitution of degraded forests. This document only concerns the afforestation scenario (on agricultural land, meadow/pasture, or fallow (i.e., a piece of land left abandoned and which regenerates naturally)), and reconstitution of degraded stands (i.e. in this case, according to the LBC document, the reference scenario is that of the fallow).

MLTS: Medium to Long Term Stock ("long-term average" (LTA) in the Verra method) is a value related to the concept of permanence of carbon credits. This concept is developed further below (see Chapter 8.1).

Anticipated emission reductions (AER): AER takes standing trees' carbon storage into account (forest AER), and carbon storage in wood products (AER products). They are calculated by a difference between the project scenario and the reference scenario (i.e. if the project was not implemented).

Indirect emission reductions (IER): the substitution that the use of wood products from the AER products is calculated. For this, a substitution coefficient is applied according to the type of wood (see next paragraph).

2.4 Products/sector

T-YL-PW-FW percentages: T = timber (frames, beams, joinery, etc.); YL = yard lumber (pallets, panels, etc.); PW = pulpwood; FW = fuel wood (forest chips, logs, etc.). Depending on the diameter and the quality of the cut trunks, they are distributed among these different categories. Prices and lifetimes also depend on it: *FW<PW<YL<T*.

Half-life: time after which half of the carbon (or CO_2 equivalent) stored in the wood is returned to the atmosphere due to the degradation of the material. It depends on the type of wood product: T, YL, PW or FW. (see Figure 1).

Substitution: replacing fossil energy sources (coal, petroleum, etc.) or the use of energy-intensive and/or polluting materials (aluminum, concrete) with wood. The quantities of carbon avoided by the use of this renewable material rather than another non-renewable one are said to be substituted. The coefficient of substitution depends on the type of wood product: T, YL, PW or FW.

3. Raw data

The raw data is taken from EcoTree forestry management plans which formalize annual data per hectare. For the method, the following data is used:

- number of stems,
- stems' total volume,
- Volume harvested in the case of a cutting year,
- stems' average diameter,
- the percentage distribution of logs into fuelwood, yard lumber and timber.

It should be noted that it is the timber volume, i.e. the volume of the trunk down to the cutting diameter of 7 cm, which is used in forestry management plans.

The management plans used as input concerns only one species. We use the so-called "objective" species, and percentages are indicated (when available) on expert foresters' attestations. When on certain plots of land various species are planted as 'objectives' , the calculations are made separately for each plot.

4. Calculating the carbon sequestered in the forest ecosystem using the LCL method adapted to 100 years

First, we calculate the quantities of carbon sequestered in the different compartments of the stand (Gleizes, 2017 and Carbofor, 2004).

The total carbon storage over 1 ha at time t is equal to $(ab+br).tc+S_{soil}+S_{lit}+d_{wood}$, expressed in tDS. This result is multiplied by 44/12 to find the result in tonnes of CO_2 equivalent (tCO_2e).

By detailing each coefficient:

Above ground biomass (ab):

$$Ab= vol.exp_{aero}.infradensity$$

expressed in tDS with:

- *vol*: tree stems' volume at time t over one hectare,
- exp_{aero} : coefficient of aerial expansion. "Branch" expansion factor of 1.335 for conifers and 1.611 for hardwoods, taken from the LBC or from other sources when the species does not appear in it (for example for Thuja, see reference),
- *infradensity* : the values used are defined by species (Label Carbon Label, 2020).

Root biomass (rb):

$$rb= e^{-1.0587+0.8836.\ln(ab)+0.2840}$$

expressed in tDS (LBC, 2020 based on the work of Cairns et al., 1997)

Total carbon sequestration in the tree is obtained by multiplying (*ab*+*rb*) by t_c: carbon rate = 0.475 tC/tDS (IPCC, 2006).

Carbon storage in the soil:

Differs depending on the baseline scenario. It is considered that for agricultural land, the soil regenerates to return to the equilibrium of 70 tC/ha from 45 tC/ha.

$$S_{soil} = C_{ref} + (Cf - C_{ref}).(1-e^{-0.0175.t})$$

since (Arrouays et al., 2002) p.161. Of course if Cref = Cf (for enrichment or meadow) then Ssoil = Cref = 70 tC/ha.

Carbon storage in the litter:

The Label Bas Carbone suggests that equilibrium is reached at age 30. We therefore consider that the stock is in equilibrium thereafter.

$$S_{lit} = t(L_{eq}-l_0)/30$$

for $t \leq 30$ years

$S_{lit} = L_{eq}$ for $t > 30$ years

With L_{eq}= equilibrium carbon stock = 10 tC/ha.

Carbon storage in the understory:

It is considered that the understory accounts for 2.4 tC/ha for hardwoods and 6.5 tC/ha for conifers (Carbofor, 2004). These coefficients are not implemented to date in this method.

Carbon storage in dead wood:

The Label Bas Carbone considers it negligible, and thus $d_{wood}=0$.

Within their 30 years framework this hypothesis is valid, but it is unclear if it is true over 100 years. However, EcoTree implements management in irregular silviculture, with light but more frequent cuts. Dying trees are therefore harvested before they become dead wood. To meet the standards for biodiversity, 3 or 4 dead trees (or "organic trees") are kept per hectare. Their volume is currently considered negligible.

5. Computation of sequestered carbon in the reference scenarios

In order to follow the LBC methodology, a reference scenario must be selected. Indeed, "Only emissions reductions going beyond this reference scenario are recognized within the framework of the Label", Low-carbon Label Standard (III.C.1).

Three reference scenarios (calculated for all t in the duration of the project) exist: takeover of agricultural land, takeover of meadows or pastures and takeover of fallow land. In the case that the project is the takeover of clearcut land, the selected reference scenario is "fallow land takeover".

5.1 Takeover of agricultural land:

There is no increase in terms of biomass which is then 5tC/ha constant.

Storage in the soil: 45 tC/ha.

There is no litter.

So, the starting constant is 50 tC/ha.

5.2 Afforestation of a meadow or a pasture:

There is no increase in terms of biomass: 0 tC/ha constant.

Storage in the ground: 70 tC/ha.

There is no litter.

So, the starting constant is 70 tC/ha.

5.3 Afforestation of land with natural colonisation by pioneer species:

It is considered that there is an increase in biomass of 1m3/ha/year by starting on an empty plot (pasture or clear cut). The LBC considers that over a period of 30 years, the reference scenario would remain exclusively fallow land. Here, over long projects (100 years and more), the ecological succession will already have had time to set up, so the fallow land gradually becomes a forest. The increase of 1 m3/ha/year therefore remains coherent. However, the increments of 1 m3/ha/year are stopped at 75 years and then remain at this stationary value of 75 m3/ha. According to experts, this is a reasonable value. It seems likely that after 75 years a stable poor coppice type forest will be reached, especially if it is used mainly to obtain firewood from pioneer species. Indeed, the method states that no wood products (calculation of the AER produced since LBC) other than firewood are harvested in this reference scenario.

For the aerial expansion coefficient, we use an average of the hardwood/softwood coefficients (i.e. 1.611 and 1.335 respectively).

We use the aforementioned biomass computation formulas with soil storage of 70 tC/ha constant at the start (either a pasture that becomes a fallow, or a clear cut that has a forest floor). The formula used to compute the litter's storage is the one adapted to a 100-year horizon (like before), since we consider that the litter is either non-existent or very damaged at the start of the project.

In terms of the production of wood products, we consider that, since the wasteland which gradually becomes a forest is not affected during EcoTree projects, wood products in this reference scenario don't exist and therefore do not store carbon, and thus there is no substitution, in accordance with the recommendations of the LBC.

6. Computing the carbon stored in wood sector products

Depending on the average diameter of the stems removed, several categories of products are differentiated. The quantities of carbon stored there, and their storage duration depend on it:

- **T** = carbon stock of wood products intended for sawing (timber),
- **YL** = carbon stock of wood products intended for industrial use. Two subcategories can be distinguished: pulpwood (PW = 44% of YL), panel wood (PaW = 56% of YL),
- **FW** = carbon stock of wood products for fuelwood. No AER is taken into account for the FW.

The following calculation method is implemented to determine the quantity of carbon in the products at time t: the carbon (tCO_2e) extracted during the years of cutting is calculated, by separating the volume of wood into yard lumber (YL) and timber (T); the percentages of quality wood by species come from the work of Cemagref-IFN, adapted for the LBC (Cemagref-IFN, 2009 and Label Bas Carbonel, 2020). We have currently implemented a version of these wood quality percentages by species taken from the IFN quality assumptions (cf. Annex 1, page); these percentages already take into account the 50% of timber that goes to fuelwood due to sawing yield (Label Bas Carbone, 2020).

6.1 Taking half-lives into account:

For the years between cuts, we calculate the degradation of the storage of CO_2 equivalent (equation of half-lives according to the type: YL = 25 years, T = 35 years, PW = 2 years; see figure 1) of the previous sections.

This is calculated for each cut by:

$$C(n+1) = C(n).e^{-k} \text{ with } k= \ln(2)/t_{half} \text{ (Pingoud, 2006)}$$

During cutting years, we compute this storage based on the percentage of each type of wood. As the cuts are made at the end of the year, we do not take into account the degradation of stocks added during the cutting year, but the degradation of all wood stocks produced from previous years. Each year ‘t’ we therefore take an inventory of the total carbon stock (here CO_2 equivalent) stored individually in the different types of wood products: FW, PW, YL and T.

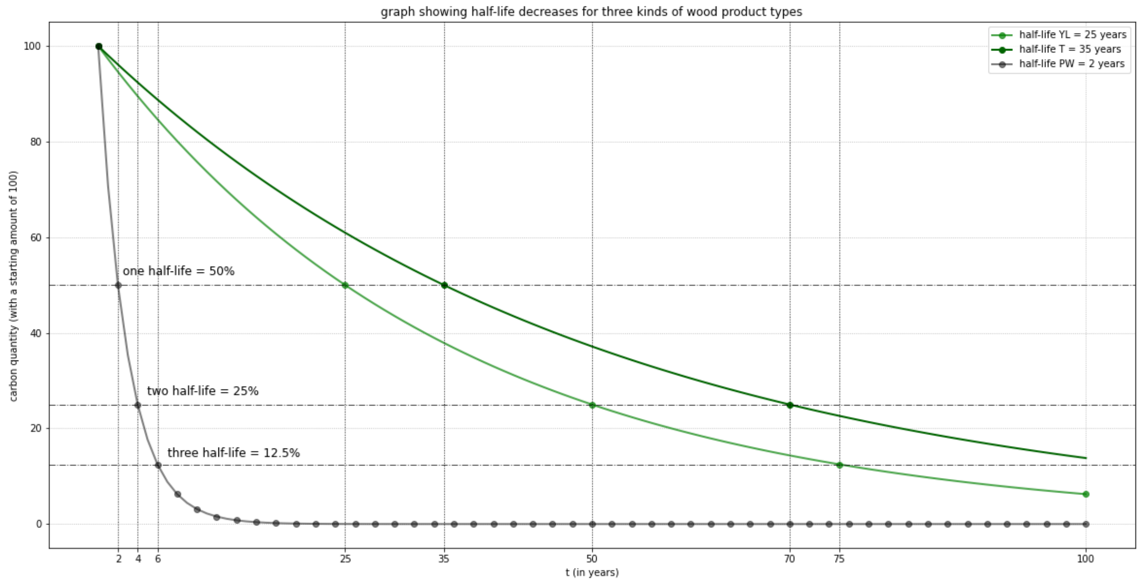

Figure 1: Half-lives for the different classes of wood products

7. Computing the substitution effects

Substitution concerns the different product categories: FW, YL and T. The following coefficients (Label Bas Carbone, 2020) are used:

- **T** = 1.52
- **YL** = 0 for paper (PW = 44% of YL), 0.77 for panels (FWa = 56% of YL)
- **FW** = 0.25

This is a multiplication of the volume of carbon extracted by the substitution coefficients, taking into account the wood quality percentages as well as the sawn timber. The calculation is carried out by section and cumulatively. It is consistent to consider these substitution effects as cumulative and definitive (ONF[1], webinar 08/12/2020) to obtain an overall final figure. Likewise, "the curve has a particular shape with levels corresponding to a threshold of emissions avoided at each thinning carried out which makes it possible to mobilize additional wood for construction, for example. (Gleizes, 2017)

8. LTAS concept

8.1 LTAS/LTA concept explained

-LTAS: Long-term average stock

-LTA: long-term average

[1] National Forestry Office (French)

The word "average" used in this term is ambiguous. Although the calculation suggests that it is an average, because the values on which the equation is based are cumulative values (the stock of strong wood on a forest plot or, by extension, the carbon dioxide sequestered on that plot)- it is not an average. It therefore makes no sense to talk about an average.

The LTAS concept is related to **the concept of permanence of carbon credits. In essence, it defines the maximum theoretical value of the volume of wood on a forest plot, over an infinite time.** This concept is particularly important when the wood stock fluctuates strongly, for example in the case of even-aged management (or regular forestry). This concept is particularly important when the wood stock fluctuates strongly, for example in the case of even-aged management (or regular forestry) where there is a succession of forest rotations (planting, thinning, clear-cutting, etc.). In this case we have the "infinite" repetition of a pattern, the LTAS represents a statistical value if it were constant. The formula would be to add up the stock of wood per year, all years from 0 to n, and divide by the number of years (i.e. n), which is infinite. We must therefore take the limit when n tends to infinity. Mathematically, this is equivalent to doing the calculation on a rotation (it is repeated identically to infinity, the "number of rotations “simplifies itself”).

8.2 LTAS adapted to EcoTree’s irregular sylviculture

Concerning the previous calculation, in cases with no recurring pattern, the Verra method recommends taking the value of n = project duration. **In other words, if we place ourselves in a forestry context, we would carry out a clear cut at the end of the project and start again with an identical project, creating a pattern.** In the rest of this document we will call this method the Verra method (see last entry in §15: references). We believe that this does not adequately represent the reality of the irregular type of forestry that we practice.
Indeed, irregular forestry is unique in its **aim to reach a steady state where all the volume that is extracted from the forest is replaced by natural regeneration, tending towards a stationary state.** EcoTree has modelled this as a series of identical patterns which represent the evolution of the stock of timber volume between each thinning, which repeats itself ad infinitum. The LTAS, in this case, is the value calculated as before based one of these patterns[2]. Figure 2 proposes a Douglas fir example, and figure 3 one with sessile oak. In the rest of the document, we will call this method the "infinite" method.

It should be noted that in the case of an agricultural reference scenario the final pattern is not really stable over time. This is due to the soil carbon storage equation (see section 4). We still use the final pattern for the calculation as we remain conservative in doing so, with the agricultural soil slowly moving towards a richer forest soil.

Similarly, the case of produced stocks is more complicated as it is not really stable either but evolves slowly over time; in most cases it increases. However, we use the same method (i.e. the last pattern

[2] Our forestry modelling leads us to define a pattern that corresponds to the volume/time function between two thinnings. If we pose this pattern as the term of a sequence, there is a certain rank N from which the difference between two terms tends towards zero. In fact, from the moment we are in the irregular zone (steady state) this difference is by definition of the model equal to zero, this same pattern being repeated ad infinitum. This sequence is therefore a Cauchy sequence. Moreover, this modelling is carried out on R (the set of real numbers, of finite dimension 1), thus a Banach space. The sequence is thus convergent (towards a limit value, here the LTAS/LTA). The beginning of the management plan has no conceptual impact on the limit value, which only depends on the stationary state.

is assumed to repeat itself ad infinitum) which implies a conservative value and is in the direction of respecting nature versus the model[3].

In the case of the reference scenarios, the values being stationary (the wasteland scenario becomes stationary from 75 years onwards), **the LTAS values are these stationary values**, whatever the method (Verra or "infinite"). For example, for fallow land the LTAS is 75 m^3/ha.

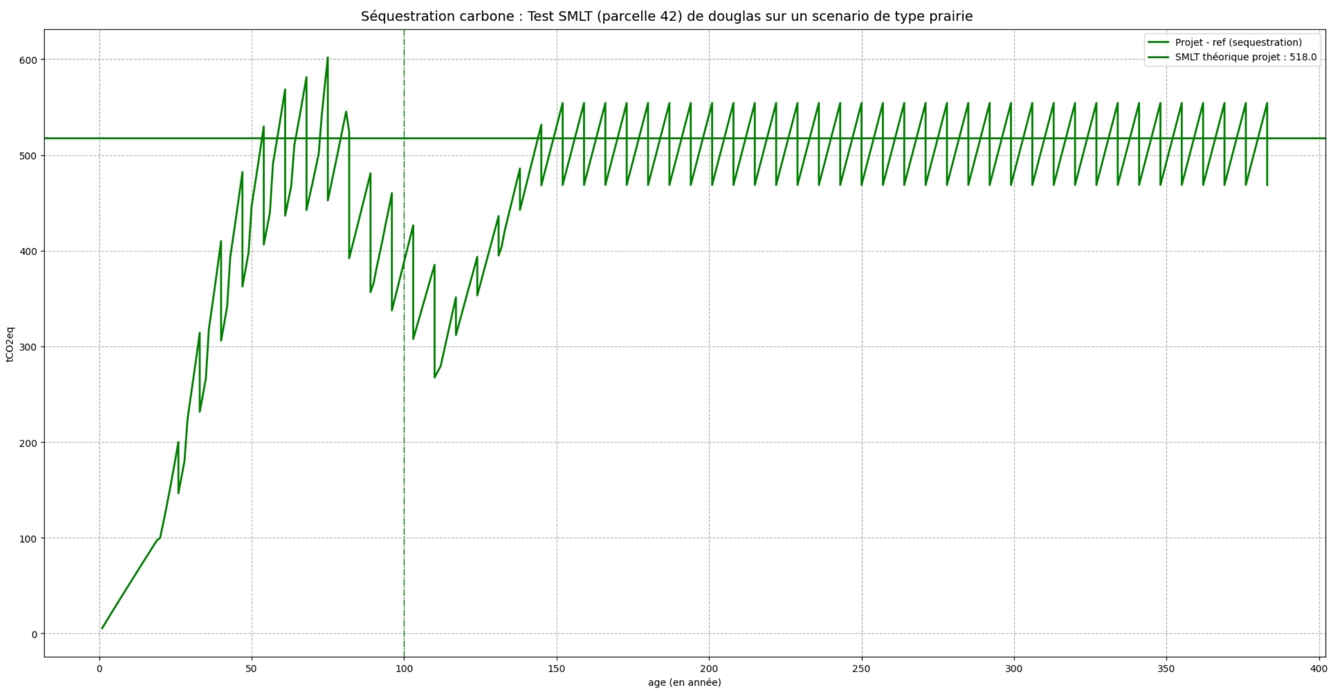

Figure 2: Example of an irregular Douglas fir management plan’s carbon sequestration, for a fallow type scenario

[3] La méthode de calcul par demi-vies est déjà basée sur des coefficients conservateurs

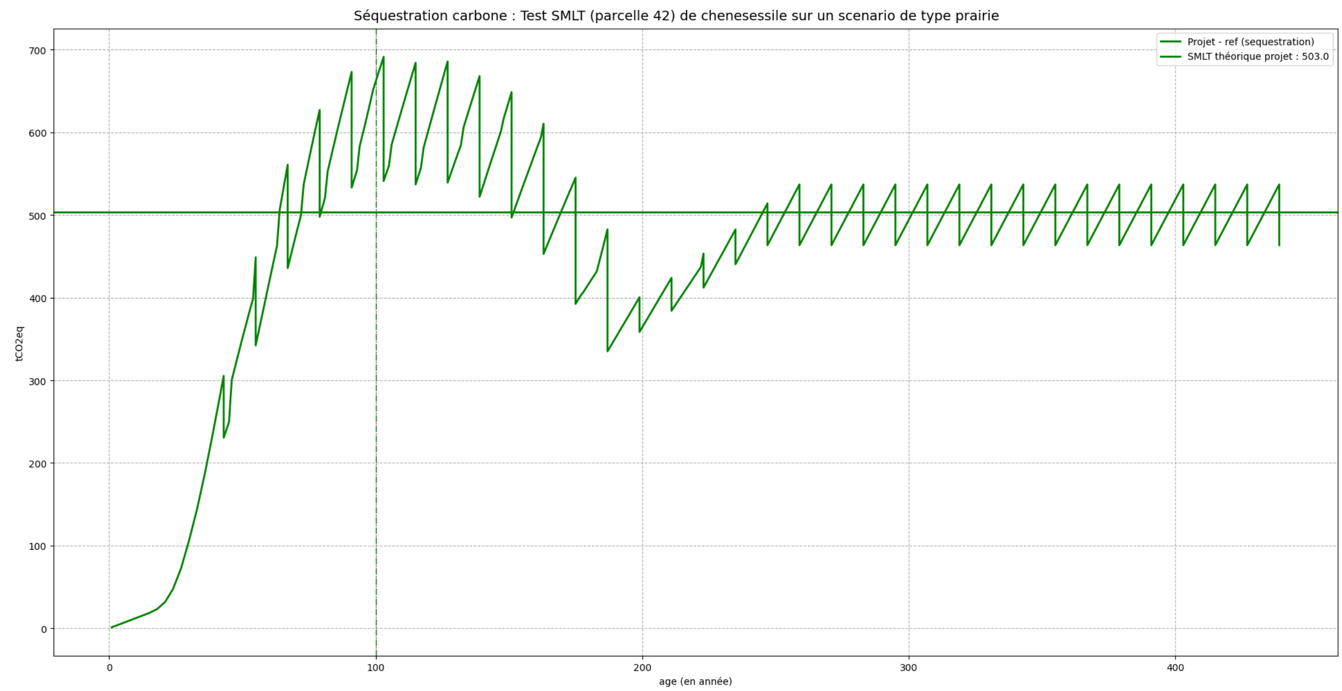

Figure 3: Example of an irregular sessile oak management plan's carbon sequestration, for a fallow type scenario

In order to **remain conservative and humble in relation to our experimental irregular forestry model, a discount (buffer) of 10% is applied to the LTAS calculation**, whether on the sequestration part or on the stock part of the wood products. However, once again to remain conservative, this discount is not applied to the LTAS calculations of the **reference scenarios**.

9. Computing the Anticipated Emission Reductions (AER) that can be generated due to carbon sequestration by the forest ecosystem

The AER are always calculated in relation to a reference scenario and over the entire duration of the project. To calculate them, the minimum must be sought between:

- the difference between the storage in the forest ecosystem of the project and the storage of the reference scenario at the end of the project (100 years).
- the difference in Medium Long-Term Stocks (MLTS) over the duration of the project.

$$\mathrm{AER}_{\mathrm{forest}} = min(\Delta S(100), \frac{1}{R}.\sum_{n=0}^{R} S_{projet}(n) - \frac{1}{R'}.\sum_{n=0}^{R'} S_{ref}(n))$$

with:

- $\Delta S(100)$: difference in carbon sequestration in year 100 between the project scenario and the reference scenario (in tCO_2e),
- $S_{project}$: carbon sequestration in the forest compartments of the project scenario (in tCO_2e),
- S_{ref}: carbon sequestration in the compartments of the reference scenario, (in tCO_2e),
- R: rotation duration of the project species,

- R ': rotation duration of the reference scenario. If the age of exploitability of the increments is not known, we will apply the same age as for the project scenario, therefore R = R '.

10. Computation of AER that can be generated due to carbon storage in wood industry products

Just like AER that can be generated through sequestration, AER contributions to carbon storage in wood products are calculated at the end of the project. The value is calculated according to the formula below, over the project's duration (100 years). The differences in carbon storage in wood products between the project and the reference scenario are used. In the case of taking back agricultural land or meadows/pasture, there are of course no wood products. In the case of colonisation by pioneer species, we consider that the plot is not exploited so there are no wood products either.

The produced REA formula is the following:

$$\mathrm{AER}_{\mathrm{products}} = \frac{1}{100} \cdot \sum_{n=0}^{100} (C_{projet}(n) - C_{ref}(n))$$

with:

- C_{projet}: stock of carbon in wood products that would be harvested in the project scenario (in tCO_2e),
- C_{ref} : stock of carbon in wood products that would be harvested in the reference scenario (in tCO_2e).

11. Computation of Indirect Emission Reductions (IER) that can be generated

They are calculated in the same way at the end of the project. This time, it is the cumulation (over the project's duration, i.e., 100 years) of the differences in carbon storage in wood products between the project and the reference scenario that is computed. The result is then multiplied by the substitution coefficients. Therefore, it is directly the previously computed figures that are used, since there is no substitution in the reference scenarios because there is no production of wood products for those. These figures are purely indicative and should not be used other than as communication/pedagogy to change consumption practices, etc.

12. Use of figures

EcoTree's end-of-project carbon forecast figures for forestry projects (at t = 100 years) are the values calculated according to the "infinite" LTAS method, purely additional for the sequestration and wood product stock parts, as well as, indicatively, the IER for the substitution part at the final date. By this is meant the said LTAS 'infinite' value of carbon sequestration at the end of the project (with the 10% discount), plus the LTAS 'infinite' value of storage in products (ditto for the discount), minus the LTAS 'infinite' value of sequestration of the reference scenario (without the discount). In fact, there is no storage in wood products for our reference scenarios (agricultural or grassland, obviously, but also wasteland, depending on the hypothesis made (cf. relevant paragraph)).

This value is preferred to the AER value, which is very conservative and does not apply to EcoTree's forestry strategy, which values long-term management through the implementation of irregular management plans. Indeed, EcoTree's afforestation or reforestation projects are not intended to result in clear-cutting but to consolidate the forest heritage and biodiversity of a complete forest ecosystem. In the same way, working with the living world on long-term projects implies that EcoTree's clients accept the inherent risks. When preparing its forest management plans, EcoTree takes into account expected climate change hazards (to the best of current knowledge), in its choice of species to plant and theories of ecosystem resilience as parameters.

Thus, for each forestry project that includes plantation, three metrics are calculated:

- the value called "EcoTree balance" which corresponds to the additional carbon stock at the end of the project (i.e. *project sequestration -reference scenario sequestration+project products stock*), often it is at 100 years that the projects stop. Denomination **Sequestration balance and additional carbon storage at 100 years**, this value is indicative.
- the AERs (forest + produced stocks + total) calculated according to the LBC equations with the LTAS Verra method (i.e. over the duration of the project, most often 100 years). Denomination **Forest AER**, **Products AER** and **Total AER**. In cases where a project's end date corresponds to a felling date, the sequestration and product stock values (and therefore the possible substitutions) used correspond to the values "before felling", since it is considered that felling is carried out at the end of the year.
- the "forest" + "produced stocks" + "total" values calculated according to the "infinite" LTAS method. It should be remembered that the "forest" value corresponds to the additional value, i.e. the difference between the project and the baseline scenario. Denomination **LTAS/LTA "infinity" forest**, **LTAS/LTA "infinity" products**, **SMLT/LTA "infinity" total**.

13. Verification

EcoTree therefore calls on Bureau Veritas for each stand in order to:

- verify the consistency between the forestry management plans validated by the expert and those used for the carbon quantification of projects,
- verify the content and compliance with the EcoTree carbon methodology,
- attest to the correct application of the carbon quantification computations according to the forestry management plan: in the reference scenario, in the project scenario; over the period defined by the management plan.

14. Limits

EcoTree nevertheless draws everyone's attention to the fact:

- that seeing as the living world is by definition difficult to quantify, this carbon captation methodology is in itself an estimate and by no means a perfect and just measure, for the following reasons:

    (i) it is based on our methodology for forestry management plans, a new methodology for resilient forests, theoretically correct, but that the living world and natural hazards (notably global warming) might change;

    (ii) it is made *ex-ante*, in other words this estimation stems from a forward-looking assessment of forests and their carbon sequestration. Thus, it allows us to frame the carbon sinks that the forest will likely create during the cycle in question;

    (iii) hence, figures are rounded to the CO2 equivalent tonne;

    (iv) furthermore, an *ex-post* measure made by EcoTree and its teams will enable us to make the effective carbon capture more precise, year after year.

- That any action aiming to contribute to the creation of carbon sinks only makes sense if it's part of a more global approach, including avoidance and reduction,
- that getting involved with forestry solely for its carbon sequestration and storage capacity could encourage the development of management that is not sustainable or respectful of the environment and its biodiversity.
- that the principle of economic additionality, according to which the project would not have been economically viable without the sale of carbon credits, is not applied in EcoTree's methodology either. As a reminder, the *Label Bas Carbone* has put in place this notion to avoid windfall effects of a forest owner who would have, in any case, carried out this forestry work. EcoTree's client, who is both the project's financier and the owner of the trees, has an assumed economic interest, since he will be able to benefit from the income from the harvesting of the woods whose management he has financed over the long term.

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16. Annexes

16.1 Annex 1 - Percentages of different qualities of wood

We select these percentages according to the diameters (according to the IFN), data modified to take into account the assumptions of the Label Bas Carbone (50% of sawn wood lost, spent in FW).

Oak			
AvgDiameter (cm)	**FW**	**YL**	**T**
<27.5	0%	100%	0%
[27.5- 47.5[	35%	30%	35%
≥47.5	45%	10%	45%

Beech			
AvgDiameter (cm)	**FW**	**YL**	**T**
<27.5	0%	100%	0%
[27.5- 47.5[	30%	40%	30%
≥47.5	45%	10%	45%

Fir + Spruce			
AvgDiameter (cm)	**FW**	**YL**	**T**
<22.5	5%	90%	5%
≥22.5	40%	20%	40%

Scotch pine + Maritime pine + other softwoods			
AvgDiameter (cm)	**FW**	**YL**	**T**

<22.5	0%	100%	0%
≥22.5	35%	30%	35%

Other hardwoods			
	FW	**YL**	**T**
AvgDiameter (cm)	25%	50%	25%

16.2 Annex 2 - Method evolution

The EcoTree methodology is now in its third major version, here is a reminder of the main steps:

- Version 1 - adaptation of the Low Carbon Label to EcoTree's 100-year forestry projects.
- Version 2.x - updated from version 2 to include aerial expansion and infradensity coefficients for species not available in the official Low Carbon Label document.
- Version 3 (current version) - added part on permanence clause and explanations on LTA and LTAS concepts, changed duration before stabilisation for wasteland scenario, created "LTA infinity" metric.