Help Manual for the Tool for Calculating Carbon Dioxide Absorption in Seagrass Meadows and Tidal Saltmarshes

Socios beneficiarios:

Cofinanciador:

INDEX OF CONTENTS

1. Acronyms, units, and glossary

C: carbon.

%C: percentage of the biomass that is carbon.

CO_2: carbon dioxide.

DOC: dissolved organic carbon.

UAs: units of absorption.

GHG: greenhouse gases.

ha: hectare (10^4 m^2).

m^2: square metre.

mm: millimetre.

mmol: millimoles (10^{-3} moles).

N_2O: nitrous oxide.

FW: fresh weight.

t CO_2 eq: ton of carbon dioxide equivalent.

t: ton (10^6 g).

µmol: micromoles (10^{-6} moles).

Epigean biomass: living biomass; either from seagrasses, or from marsh plants that are located on top of the sediment.

Hypogean biomass: living biomass; either from seagrasses, or from marsh plants buried in the sediment.

***Ex-ante* calculations**: foreword calculations based on estimates carried out for changes in carbon stocks in the various sinks over the period of performance of the project. The estimated result will provide an approximate forecast of the levels of absorption that are expected to be generated by the project.

***Ex-post* calculations**: measurements of the changes that carbon stocks have undergone in the various sinks taken at a specific time during the period of performance of the project. The result of the estimations will provide information on the absorptions that have actually taken place in the project at the time of calculation.

Base(line) scenario: the current scenario and the evolution of that scenario during the period of performance of the project, taking into account the expected current and future processes.

Project base(line) scenario: that which will exist as soon as the project is initiated and its expected evolution up until the end of the period of performance.

Low marsh: the zone closest to the water lamina at low tide and which becomes covered by water due to the daily tidal effect.

Mid marsh: a zone of marsh that is partially flooded during high tides with coefficients greater than the average high tide, and sits on partially developed soils.

High marsh: a zone of marsh that is very rarely inundated, only during the peak high tides of the lunar cycle.

Dead matter (or necromass): mainly composed of non-living plant remains, both autochthonous and allochthonous, which are trapped among marsh plants or shoots of seagrass.

Intertidal meadows: those located in areas where there is daily alternation of periods of immersion and emersion. This zone is bounded in the top part by the mean level of the spring tides and towards the bottom by the mean level of the equinoctial low tides.

Shallow subtidal meadows: represent those found in shallow areas, approximately between -0.3 m and -7 m in relation to the tide at its lowest ebb.

Intermediate and deep subtidal meadows: represent those thriving in areas below the shallow subtidal. Depending on location, different zones can be defined according to the depth at which they are found, as intermediate subtidal (-7 m to -15 m) and deep subtidal (>-15 m).

Period of performance: the period of time during which the developer undertakes to manage the project and to guarantee the satisfactory conditions of its development.

Carbon pool or sink: compartment of the ecosystem (biomass, soil, DOC, dead matter, etc.) where carbon dioxide can accumulate or be released.

Units of absorption: tons of carbon dioxide, removed or not emitted during the period of performance of the project as a result of the net balance of carbon dioxide emissions/removals in the baseline scenario and the project scenario.

This document is accompanied by the document “Methodology for the estimation of carbon stocks and emission factors in tidal saltmarshes and seagrass meadows”, which contains a more detailed description of the different terms. One should also take into account all the documentation regarding the “Andalusian Carbon Standard for Blue Carbon Credit Certification” that is available on the web.

This document forms part of deliverable 5: “Help Manual for the Tool for Calculating Carbon Dioxide Absorption in Seagrass Meadows and Tidal Saltmarshes”, as part of the project “Service contract for the elaboration of an Andalusian carbon standard for Blue Carbon Credit Certification within the framework of the LIFE+ BLUE NATURA ANDALUCÍA 14 CCM/ES/000957 project. File No: CONTR 2019 137995”.

2. Introduction

This methodology is applicable to conservation, restoration or (re-)forestation projects in tidal marshes and/or ecosystems dominated by seagrass meadows, i.e. in blue carbon ecosystems. These ecosystems have the long-term ability to capture carbon both through the absorption of carbon dioxide (CO_2) through photosynthetic activity and their ability to fix carbon in sediment over the long term. This carbon retained in sediments accumulates for hundreds or thousands of years due to the anoxic conditions that prevail there and the constant rates of sedimentation that exist in coastal zones. Therefore, the implementation of projects that conserve, restore or (re)forest these ecosystems will allow for continuous carbon capture over long periods of time, contributing among other benefits to the mitigation of climate change.

The methodology is based on the calculation of the reduction in greenhouse gas (GHG) emissions that occurs when moving from the current situation (base scenario) to a future situation (project scenario), following the implementation of one of the projects mentioned above. The project should lead to a substantial improvement in these communities, favouring either an increase in carbon capture in the different pools that exist in the ecosystem (biomass, soil, dissolved organic carbon, etc.), and/or a reduction in GHG emissions (CO_2, methane and nitrous oxide) in relation to the baseline scenario conditions. Those projects that fail to achieve a net reduction in GHG emissions in relation to the baseline conditions will not be accepted.

3. Application of the calculation tool

It should be borne in mind that natural systems are complex and that there are a multitude of spaciotemporal interactions and variations that will affect the carbon absorption capacity of each of the sinks to be analysed. In addition, there is a significant scientific uncertainty arising from a lack of knowledge about the effects of some variables on carbon fluxes and the absence of specific data on certain species, locations, conditions, etc. This intrinsic difficulty does not prevent an *ex-ante* calculation being made using the calculation tool provided, although the prior analysis and detailed study of the conditions in the baseline scenario and in the project scenario are *sine qua non* requirements without which the application of this calculation tool would lose its usefulness.

The design of the calculation tool incorporates various spreadsheets that will allow the calculation of CO_2 emissions/removals in both the baseline scenario and the project scenario taking into account the variations in carbon stock encountered in each of the pools being analysed. This will require values to be entered for the different parameters that make up the calculators and these will have to derived from from the databases that accompany this calculation tool, although these can also come from published data of proven reliability, or else direct measurements taken at the site where the project is to developed. When using data not included in the databases provided by the tool, it will be necessary to include a detailed report containing the assumptions, calculations, equations, methodologies, etc. that have been used, and that allow for verification of the reliability of the data and the calculations made.

In either case, it should be noted that the *ex-ante* calculations of CO_2 emissions/removals provided by the tool are very much dependent on the data entered into the calculator, and therefore, in order to make sure they differ as little as possible from the *ex-post* calculations, a methodical and detailed analysis of the baseline scenario and its evolution should be carried out before any initiation of the project, as well as a subsequent methodical and detailed analysis of the project scenario; in both cases, for the entire period of performance of the project. By way of recommendations, in the case of the baseline scenario, the historical evolution of that area and its communities should be analysed, a proper environmental diagnosis carried out including a complete environmental inventory with the pre-operational description and analysis of the condition in which it is found, the origin and forces that have led to its current state, the description of the main ecological and environmental relationships that predominate in the area, the delimitation and mapping of the project area, a description of the activities, projects, plans, etc., whose implementation may affect the project area in the future, and finally an analysis of the evolution of the area during the period of performance of the project taking into account all the information previously collected. In the event that the effects of climate change (e.g. rise in sea level, rise in temperature and concentration of CO_2, increase in storm frequency, etc.) are considered to significantly affect the evolution of the area during the project period, these effects should be included in the analysis.

Once all this analysis has been completed, a selection should be made of those parameter values that in the fullest and most integrated manner reflect the average conditions that will occur during the period of performance of the project in the baseline scenario. All assumptions and motives leading to the selection of a value must be sufficiently justified and documented. In the case of the project scenario, estimates should be made of the future evolution of the area during the performance of the project once the project has been carried out. To this end, it is essential that an analysis is carried out taking into account similar previous experiments that have been developed and which will be indicative of the planned evolution of the project.

It is important to note that, right from the outset of the project, there will be a first phase of growth or slow evolution in the capacity for CO_2 capture in many pools, followed by a phase of rapid growth, until reaching a phase of equilibrium that will be maintained over time. The points (moments) that mark the passage from one phase to another are variable and dependent on species, location, environmental conditions, previous or pre-operational status, performance, etc., and should be taken into account by conducting a detailed analysis of the existing bibliography and the analysis of analogous projects carried out in similar or comparable locations (methodology of comparative scenarios). In order to achieve this, expert opinion can also be obtained through the various existing methodologies (e.g. the Delphi method).

Following this thorough analysis, values of the various constituent parameters should be selected that cover the entire period of performance of the project and take into account the duration of each of these phases. As in the baseline scenario, if it is thought that the effects of climate change (e.g. rise in sea level, rise in temperature and concentration of CO_2, increase in storm frequency, etc.) will significantly affect the evolution of the area during the period of performance of the project, these effects should be included in the analysis.

Firstly, the required data must be entered in the “General Project Data” sheet. This sheet holds fundamental data that have a highly significant influence on the results generated by the calculation tool, such as the “total project surface area” and the “period of performance”. In the first case, the total area of the project where the planned activity is to be carried out should be entered. For the period of performance, the period of time during which the developer undertakes to manage the project and to guarantee the satisfactory conditions of development of the project should be entered. The minimum period of performance is 10 years and the maximum period is 50 years. However, this maximum period may be extended for a further period of up to 50 years, and this should be indicated in the “further period of performance” cell. It is important to note that the absorption values generated by the calculation tool refer only to the general performance period, and that once this deadline has been reached the project is to be revalued and the calculations for the further period repeated.

Unlike terrestrial ecosystems where a large proportion of carbon is retained in the biomass of photosynthetic organisms, in blue carbon ecosystems the largest proportion of this carbon is buried in the sediment. Nevertheless, in the case of both seagrass meadows and tidal saltmarshes, the pools listed below have been taken into account in the calculation tool and it is mandatory that they are entered into the calculation tool.

1. **Biomass pool**: this consists of the carbon retained in the living biomass of seagrass and marsh plants, present in both their epigean and hypogean biomass.
2. **Sediment pool**: this consists of the organic carbon buried up to a depth of 1 metre in the sediments where both the seagrass meadows and the tidal marshes develop.
3. **Dissolved organic carbon pool**: this comprises the fraction of organic carbon produced and released into the water column by these ecosystems and which cannot be weighted or measured directly, since it is of less than 0.2 µm in size. Of the organic carbon so produced, only the recalcitrant fraction is that which is considered to be a long-term sink.
4. **Methane pool**: this consists of the greenhouse gas emissions arising from the sediment of these communities and which is finally released into the atmosphere.
5. **Nitrous oxide pool**: this comprises the emissions of this greenhouse gas arising from the sediment of these communities and which is finally released into the atmosphere.

In the case of the project, two other pools are also included:

6. **Project activities pool**: this consists of all those emissions that are generated during the initiation of the project and which may be caused by the movement of vehicles, transport of materials, movement of the sediment and oxidation of the carbon contained within it, elimination of plant biomass, etc.
7. **Induced activities pool**: this consists of those emissions that might be generated outside the project area in the event of a displacement of activities or impacts due to the initiation of the project. If it is considered that there will be no emissions

produced due to the initiation of the project, an entry of zero emissions will be made.

3.1. Baseline emissions/removals calculator

Starting in the top section, the species involved in the project should first be selected, and an indication subsequently made of their zoning according to the options available in the drop-down lists. In the case of seagrasses, the selection should be made from the following options: intertidal, subtidal, intermediate subtidal and deep subtidal, according to the definition of terms provided in this document and expanded in the document *Methodology for the estimation of carbon stocks and emission factors in tidal saltmarshes and seagrass meadows*. In the case of saltmarshes, you must select between: low marsh, mid marsh and high marsh, according to the definition of terms provided in this document and expanded in the document *Methodology for the estimation of carbon stocks and emission factors in tidal saltmarshes and seagrass meadows*. Next, the pre-operational status in which these populations are found should be described according to the choices provided in the drop-down list. Subsequently, the potential surface area covered by the activity for each of the species and for the conditions in the baseline scenario shall be described. It is important to bear in mind that the sum of all surface areas cannot be greater than the total project surface area entered previously. For each area of activity, an entry must be made of the percentage of its surface area that is occupied by the species (or zoning) previously indicated. This will require taking into account both its current status and its expected evolution in the baseline scenario during the period of performance of the project. In the event that significant variations are anticipated during this period, an average value to incorporate this variation throughout the period must be calculated.

The calculation of emissions/removals due to the biomass pool can be made by directly entering the amount of carbon contained in the biomass (g C m^{-2}) where there are seagrass meadows or marsh vegetation. Additionally, a calculation can also be made by entering the aboveground and belowground biomass values (g DW m^{-2}) and the percentage of carbon (%C) found in that biomass. The sum total of the carbon contained in the biomass pool will be obtained only once throughout the period of performance of the project.

The calculation of emissions/removals due to the sediment pool can be made by directly entering the rate of annual emission/removals of CO_2 due to sediment (t CO_2 $ha^{-1}year^{-1}$). Additionally, it can also be calculated by entering the rates of sediment erosion/accretion in the area (mm $year^{-1}$). In both cases, negative values indicate erosion and net emissions of CO_2 into the atmosphere, whereas positive values indicate accretion and accumulation of CO_2 in the sediment. In both cases, the carbon stocks in the sediment will have to be entered (t CO_2 ha^{-1}). Annual carbon emissions/removals due to the sediment pool will be multiplied by the years of performance of the project. In the event of there being erosion or emissions of CO_2 into the atmosphere, the tool estimates the depletion time of the sediment carbon stock in the first metre of sediment ("Maximum years computable") and this estimated value will be used instead of the period of performance for carrying out the calculation.

The calculation of emissions/removals due to the dissolved organic carbon (DOC) pool is made by entering the net flux of DOC (mmoles C m^{-2} d^{-1}) and the percentage of that DOC which is refractory. Positive flux values indicate a release to the water column, while negative values indicate a consumption of DOC. Annual carbon emissions/removals due to the DOC pool will be multiplied by the years of performance of the project.

The calculation of emissions/removals due to the methane pool is carried out by entering the net methane emissions (µmoles m^{-2} d^{-1}). The annual emissions/removals of carbon equivalent due to the methane pool will be multiplied by the years of performance of the project.

The calculation of emissions/removals due to the nitrous oxide pool is made by entering the net emissions of nitrous oxide (µmoles m^{-2} d^{-1}). The annual emissions/removals of carbon equivalent due to the nitrous oxide pool will be multiplied by the years of performance of the project.

3.2. Project emissions/removals calculator

Starting at the top, a selection should first be made of the potential surface area to be occupied by each of the populations selected above once the project has been developed, as well as the percentage of this area they occupy after the project has been developed. It is only to be expected that on initiation of the project there will be an increase in the percentage of surface area occupied, which is why the estimated value must be entered once the equilibrium state has been reached. It is important to note that the sum of all surface areas cannot be greater than the sum of the areas previously entered in the baseline.

The use of the different calculators for the various pools is identical to that explained in section 3.1. However, there are two new pools: “project activities” and “induced activities”.

In the case of the project activities pool, all those activities carried out on initiation of the project (and in its maintenance during the period of performance) that can result in the emission of CO_2 into the atmosphere must be considered, such as the movement of vehicles, the use of machinery, watercraft, the transport of materials and personnel, the removal of sediment and oxidation of the organic carbon it contains, the removal of plant biomass in the project area, etc. This will involve taking into account the number of working hours of each of these vehicles and/or machinery, the average fuel consumption (l h^{-1}), the type of fuel used and the emissions factor (Kg CO_2 l^{-1} or Kg CO_2 kWh^{-1}) depending on the type of fuel used. These values are included in the “Emission Factors” tab found in the tool. In the case of the removal or burning of biomass in the project area, it will be necessary to include estimates of biomass (t DW) to be removed or burned and the average carbon content of that biomass (%C), a figure that in the case of marsh plants or seagrass will be obtained from the databases included in the tool. If there is any movement of sediment where it is thought that the carbon present may oxidize, the volume of sediment moved (m^3) and the CO_2 content of that sediment (t CO_2 ha^{-1}) should be included, a figure that in the case of marsh plants or seagrasses can be obtained from the databases included in the tool. The sum total of the carbon emitted in the project activities pool will be obtained only once throughout the period of performance of the project.

In the case of the induced activities pool, it will be necessary to analyse whether the execution of the project may involve a shift of activities or impacts to areas outside the project area, and whether these activities or impacts lead to an increase in GHG emissions. Under these conditions, it will be necessary to demonstrate that the shift to other areas is due to the execution of the project, and a full calculation of the emissions produced by the induced activities will have to be carried out throughout the period of performance of the project. Should this be the case, a detailed report must be included explaining the assumptions, equations, calculations, results, etc., by which they can be validated. If it is thought that emissions will not occur due to induced activities, a value of zero is to be entered in the corresponding cell.

3.3. Results for baseline and project scenarios

Both tabs include a summary of the results obtained from the different calculators, both partial values of the annual CO_2 emissions/removals for each of the pools (top section), as well as throughout the period of performance of the project (bottom section). Finally in the bottom section, an entry should be made of the total CO_2 emissions/removals originating in the baseline scenario and the project scenario, taking into consideration all the pools and the years of project performance.

3.4. Summary

The sheet relating to the summary values of emissions/removals shows the summary of CO_2 emissions/removals in both the baseline and the project scenarios, and *ex-ante* estimates of the absorptions generated by the project (net balance between the project emissions/removals and the baseline scenario). From these values, calculations can also be made of the *ex-ante* UAs (20% of those generated), the UAs that will go to the reserve fund (9% of the *ex-ante* UAs) and the *ex-ante* AUs available to the developer.

3.5. Databases

The calculation tool has three databases: “seagrass database”, “saltmarsh database” and “emission factors”, which contain detailed values for all the parameters used in the different calculators of the different pools. The database is differentiated by species, location and type of community and different values are included for many of the parameters so that those most appropriate to the specific conditions can be selected in accordance with the analyses carried out in both the baseline scenario and the project scenario. The databases are derived from an extensive list of up-to-date references which have been fully and scientifically validated.

3.6. Calculator updates

This tab includes a history of the several versions of this tool and the major changes that have occurred in each new version.