METHODOLOGY

PSA CARBON AGRO PERENE

Table of Contents

List of tables

List of figures

List of equations

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Preface

Upon becoming aware of the PSA Carbonflor methodology, developed by ECCON with contributions from Reservas Votorantim, and understanding the importance of an effective remuneration mechanism for environmental service providers, Citrosuco, a company recognized in the Brazilian agricultural sector, urged ECCON to expand the scope of PSA projects to encompass productive areas that also have preserved areas, in particular areas occupied by perennial crops.

ECCON, in turn, recognizes the relevance of cultivated areas for the provision of ecosystem services, insofar as good agricultural practices combined with practices for the conservation of forested areas within productive properties constitute a combination that enhances the generation of ecosystem services to be enjoyed by society as a whole – especially in a country where the agricultural sector has significant weight in the economy and has rural producers highly engaged in improving cultivation practices on the basis of technological evolution.

It was by combining these rationales that this Methodology was developed in all of its technical aspects by ECCON professionals, with support from Reservas Votorantim and from Citrosuco, which contributed by sharing data, information and expertise, in particular regarding agricultural practices, and with contributions to the improvement of the Methodology during its development phase.

1 INTRODUCTION

This Methodology was developed by ECCON's technical team, with contributions from Reservas Votorantim, in order to quantify and value Environmental Services and enable the execution of Payment for Environmental Services projects on rural properties that share the space of cultivation of perennial woody crops with protected areas, adapting national and international techniques that suit the reality of Brazilian landowners.

It is expected that the scientific work of development and improvement of this Methodology may in the future be transferred to an independent institution, preferably Brazilian and internationally recognized, so that the development team's innovation efforts may be directed to other needs of the international community.

The aim of the Methodology is to create mechanisms capable of measuring, reporting and verifying the generation, maintenance and increase of Ecosystem Services (EcS) arising from Environmental Services (EnS) on a given property, with the purpose of including them in a representative title that may be traded in the form of Payment for Environmental Services.

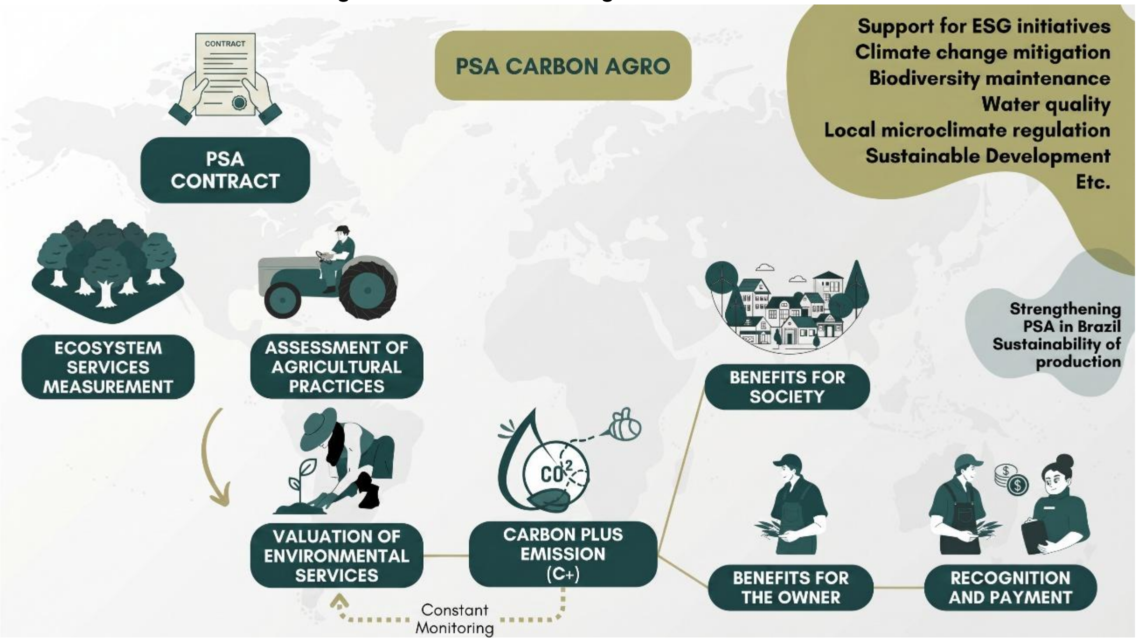
For the purposes of individualizing and commercializing the aforementioned title, Carbon Plus (C+) is created, equivalent to the figure of the carbon credit, which takes the form of a title of right over a tradable, autonomous asset, representing the reduction or removal of one tonne of carbon dioxide equivalent from the atmosphere.

The EnS, which generate, enhance or maintain EcS, will be valued and converted into titles that (i) incentivize the maintenance of the provision of environmental services, (ii) contribute to the mitigation of climate change; (iii) meet the demands for legal and methodological certainty required in national and international scientific and market forums, and (iv) promote social benefits.

C+ titles may be traded nationally and internationally, meeting the demands of society and institutions throughout the world, adding to and strengthening the current carbon market.

It is important to note that this PSA Carbon Agro Perene methodology (Figure 1), as an extension of the methodology previously developed by ECCON (PSA Carbonflor), is in line with Brazilian legislation that establishes the National Policy for Payment for Environmental Services (Federal Law No. 14,119/2021), which illuminates the concepts, objectives and guidelines set out herein, and with Law No. 15,042/24, where applicable.

Figure 1. PSA Carbon Agro Perene Model.



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2 PSA CARBON AGRO PERENE

The PSA Carbonflor initiative, forerunner of the PSA Carbon Agro Perene, arose from the need to measure and value conservation on private land, understanding that native vegetation preserved on rural properties contributes to the maintenance of hydrological cycles, to combating climate change and to maintaining biodiversity, since it serves as habitat for fauna and flora, among other benefits.

The PSA Carbon Agro Perene is an expansion of the PSA Carbonflor, stemming from the perspective that productive rural properties can combine conservation with the agricultural cultivation of perennial woody plants, thereby enhancing regional ecosystem services and allowing rural landowners to diversify their activities in line with the natural characteristics of the region in which they are located. In this way, environmental services provided through good agricultural practices are combined with environmental services of conservation and with sociocultural activities, in a combination that contributes to the expansion of biodiversity-maintenance practices, to better habitat connectivity, to the protection of soil quality and water resources, to social and environmental benefits, and to other positive outcomes. The perennial nature of these aspects represents benefits to society and ensures productive sustainability in the long term.

In this sense, and in line with what is provided for in the legislation relating to PSA (Federal Law No. 14,119/2021), it is important to distinguish between two key concepts:

a) Ecosystem Services (EcS): services provided by nature that are essential for the conservation of biodiversity, the maintenance of ecosystems and human well-being;

b) Environmental Services (EnS): individual or collective actions by people (e.g. rural landowners) that contribute to maintaining or enhancing ecosystem services.

Given the urgency of combating climate change, various initiatives are seeking opportunities to harness Brazil's potential on the climate agenda. Considering that, on a property with multiple land uses, the conservation of native vegetation and other forms of biomass provide EcS, and the application of good agricultural practices, together with the performance of sociocultural activities, also constitute EnS that generate EcS, it is necessary to develop a mechanism that fosters conservation coupled with sustainable production methods, supported by actions that generate social benefits on private land and in its surroundings.

Against this backdrop, Payment for Environmental Services is the tool that makes such a mechanism viable. The PSA Carbon Agro Perene thus emerges as a Payment for Environmental Services programme created by ECCON, aimed at the valuation and remuneration of the EnS that maintain and enhance the EcS in a given region with different land uses, such as native vegetation and perennial agricultural cultivation. Valuation is obtained through metrics linked to the provision of EnS such as forest conservation, maintenance and improvement of water quality, maintenance of habitat for biodiversity (fauna and flora), maintenance of ecosystems, monitoring, provision of support infrastructure, and by incorporating sociocultural services. In addition to what is covered by the PSA Carbonflor, the PSA Carbon Agro quantifies good agricultural practices, good sustainable management practices, and others.

In order to express the provision of EnS, measurement and verification methods are used for EcS and EnS, expressed through parameters called: (i) "Ecosystem Indicators"; and (ii) "Agricultural Practices Indicators", both detailed throughout this Methodology.

The measurement of the Ecosystem Indicators for the maintenance of EcS, and of the Agricultural Practices Indicators for sustainability, value the carbon stock measured on site, which is the backing of the Carbon. As indicated, C+ is the means of payment for EnS, as a form of financial incentive for the conservation of the environment and for the application of sustainable agricultural practices. Thus, the EnS, once recognised, mapped and measured, value the carbon stock and, together with it, become transferable assets, by means of the C+.

The C+ thus constitutes one of the modalities of payment for environmental services provided for in the legislation, which are as follows, pursuant to Article 3 of Federal Law No. 14,119/2021 (National Policy on Payment for Environmental Services):

> *"I – direct payment, whether monetary or non-monetary;*
> *II – provision of social improvements to rural and urban communities;*
> *III – compensation linked to a certified reduction of emissions from deforestation and degradation;*
> *IV – green bonds;*
> *V – loan for use (comodato);*
> *VI – Environmental Reserve Quota (CRA), established by Law No. 12,651 of 25 May 2012".*

3 DEFINITIONS

For the purposes of this methodology, the following definitions apply:

Monitoring Agent: a member of the local community or appointed individual who monitors the Ecosystem Indicators, the Agricultural Practices Indicators, the maintenance of the EnS and the vegetation cover *in situ* . This figure is created with the aim of optimising the social and environmental benefits of the project, empowering the local community, promoting environmental education and enabling the scalability of the project.

Project Area: the area of the properties included in the PSA Carbon Agro Perene where the Ecosystem Indicators and the Agricultural Practices Indicators will be measured. The Project Area may comprise one or more rural properties.

Total Native Vegetation Area (TNVA): the area within the property covered by native vegetation, whether woody or non-woody, kept as such throughout the historical period of the project, encompassing forests, other woody formations, native grasslands and grassland formations eligible for the assessment of the Ecosystem Indicators that has not suffered deforestation and/or degradation for at least 10 years prior to the start of the Valuation Period.

Woody Native Vegetation Area (WNVA): the area within the property covered by woody native tree vegetation, whether primary or secondary, that has not suffered deforestation and/or degradation for at least 10 years prior to the start of the Valuation Period.

Agricultural Cultivation Area (ACA): areas within the property designated for the continuous cultivation of perennial agricultural crops that have not been occupied by primary or secondary woody native vegetation in the 10 years prior to the start of the Valuation Period.

Area of Influence (AI): the region designated for the spatial analyses used to verify the Ecosystem Indicators and Agricultural Practices Indicators and for comparison with the Project Area.

Stored Carbon (I_{StC}): Ecosystem Indicator used to measure the EcS of carbon storage, provided by the EnS of native vegetation conservation. Carbon stock is understood to be the quantity of carbon stored in a vegetation reservoir that has the potential to accumulate (or lose) carbon over time.

Carbon Plus (C+): a title of right over an intangible, autonomous, tradable asset, backed by the EnS provided, representative of the reduction or removal of one tonne of carbon dioxide equivalent.

Sequestered Carbon (I_{SeC}): Ecosystem Indicator used to measure the EcS of carbon sequestration provided by the EnS of application of good agricultural practices in the Project Area. It also refers to the amount corresponding to the carbon removed from the atmosphere in the Agricultural Cultivation Area, converted into tonnes of carbon dioxide equivalent (tCO_2e), from a given Project Area, available for final conversion into Carbon Plus (C+).

Local Community: a group of people residing in a geographical area within or in the immediate surroundings of the Project Area, who share the same socio-economic and cultural characteristics, and who know of, and may be stakeholders in, the Project Area and its surroundings.

Perennial Crop: crops composed of woody biomass, whose life cycle is characterized by continuous growth over several years, including the reproduction and senescence periods.

Gross C+, Cultivation: a title of right corresponding to an intangible, autonomous and tradable asset, backed by the EnS provided and equivalent to the total net removal of one tCO_2e originated in the Agricultural Cultivation Area.

Gross C+, Native: a title of right corresponding to an intangible, autonomous and tradable asset, backed by the EnS provided and equivalent to the total net reduction of one tCO_2e originated in the Woody Native Vegetation Area.

Tradable C+, Cultivation: a title of right corresponding to an intangible, autonomous and tradable asset, backed by the EnS provided and equivalent to the net removal of one tCO_2e originated in the Agricultural Cultivation Area, available for trading in a given monitored period.

Tradable C+, Native: a title of right over an intangible, autonomous and tradable asset, backed by the EnS provided and corresponding to the net reduction of one tCO_2e originated in the Agricultural Cultivation Area, available for trading in a given monitored period.

Adherence Date: the date from which the EnS provider or producer undertakes to conserve the native vegetation areas located on the property, which involves the demonstration of actions for the conservation or improvement of EcS, the enhancement of agricultural practices and sociocultural activities.

Primary Data: raw data obtained directly in situ, by means of instruments and observation.

Secondary Data: data obtained indirectly through research on data platforms (whether official or not) based on the analysis of Primary Data from a given region. Examples of secondary data include: IBGE data, satellite imagery, land-use and land-cover data, etc.

Developer: a legal entity, with more than one being admissible, that develops, on the basis of the Methodology, whether through funding (hereinafter referred to as Financial Developer), the provision of technical assistance (hereinafter referred to as Technical Developer) or in some other manner, a C+ generation project under the PSA Carbon Agro, in association with its Provider in cases where the developer and the Provider are distinct;

GHG Emissions: the release of greenhouse gases and/or their precursors into the atmosphere in a specific area and period.

Carbon Pools: a carbon pool is the vegetation compartment with the potential to accumulate (or lose) carbon over time. The following may be accounted for: above-ground biomass, below-ground biomass, litter and dead wood, together with carbon stored in the soil. The quantity of carbon retained in the pool is converted into tCO_2e.

GHG: greenhouse gases listed in Annex A to the Kyoto Protocol to the United Nations Framework Convention on Climate Change: (i) carbon dioxide (CO_2); (ii) methane (CH_4); (iii) nitrous oxide (N_2O); (iv) sulfur hexafluoride (SF_6); and (v) the families of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), whose emission reductions may be converted into tCO_2e and back C+.

Ecosystem Indicator: compilation, into methodological parameters, of the set of data obtained through remote sensing, secondary and primary data, which are compiled into methodological parameters that translate the EcS and EnS of a given area into numbers.

Agricultural Practices Indicator: compilation, into methodological parameters, of the set of data obtained through remote sensing, secondary and primary data, which translate into numbers the application of good agricultural practices in a given area.

Ecosystem Indicators Matrix: a factor, expressed as a percentage, that compiles the weights and importance of the Ecosystem Indicators of a given Project Area, with the aim of adding value to the Stored Carbon indicator and enabling the issuance of C+ considering all verified EcS.

Agricultural Practices Matrix: a factor, expressed as a percentage, that compiles the weights and importance of the Agricultural Practices Indicators of a given Project Area, with the aim of adding value to the Sequestered Carbon indicator and enabling the issuance of C+.

Methodology: the set of rules and procedures developed by ECCON for implementing projects under the PSA Carbon Agro Perene. The term may also refer to the PSA Carbonflor Methodology.

Sustainable Development Goals (SDG): these form part of the 2030 Agenda established by the United Nations (UN) and seek, through their achievement, to contribute to sustainable development on a global scale.

Payer for Environmental Services (C+ Purchaser): a person or company that encourages conservation and sustainable practices, and the maintenance and enhancement of EnS, through the acquisition of C+ (see item 4.4), with a view to offsetting GHG emissions, promoting ESG initiatives and fostering sustainable development, as well as generating benefits for the EnS provider and contributing to the mitigation of climate change.

Valuation Period: a period of between 40 and 100 years for the accounting of EnS and the generation of C+, commencing with the Adherence Date and the respective proven actions of conservation and sustainable production.

Holder: a natural or legal person, whether governed by public or private law, who holds the possessory rights over the property, in accordance with Brazilian legislation.

Owner: a natural or legal person, whether governed by public or private law, who holds the ownership or possessory rights over the property, in accordance with Brazilian legislation.

Environmental Services Provider or Producer: owner or holder of an area who provides EnS and has legal standing and powers to guarantee their provision during the Valuation Period.

PSA Carbon Agro Perene: a payment programme for environmental services developed by ECCON, with contributions from Reservas Votorantim, involving the valuation, constitution and payment for EnS, by means of Carbon Plus (C+) Credits, on properties with plot(s) of preserved or conserved native area and plot(s) with perennial agricultural crops managed using good practices, with the aim of remunerating owners who are providers of EnS and meeting society's demands for the neutralisation of GHG emissions.

PSA Carbonflor: a payment programme for environmental services developed by ECCON, with contributions from Reservas Votorantim, involving the valuation, constitution and payment for EnS, by means of Carbon Plus (C+) Credits, on properties focused on the conservation of preserved or conserved native vegetation, with the aim of remunerating the Environmental Services Provider or Producer and meeting society's demands for the neutralisation of GHG emissions.

Reductions of GHG emissions: the result of activities that reduce GHG Emissions by delaying or halting the conversion of forest areas to other land uses that would cause loss, at any level, of forest biomass. By way of example, GHG emissions are reduced when the conversion of a forest area to agricultural land use is avoided. In this way, the biomass existing in the forest area (which has a significantly higher carbon stock when compared to agricultural land use) is not lost as a result of the environmental service of conservation provided (measures that led to the non-conversion of the forest area to another land use). In other words, GHG reductions are the result of activities that ensure the maintenance of carbon stocks[1]. It is important to note that climate change is already affecting the dynamics of tropical forests in Brazil, placing biomass stocks at risk, as well as biodiversity habitat and the climatic cycle.

GHG Removals: the result of deliberate anthropogenic activities that promote the removal of GHGs from the atmosphere, through carbon sequestration and storage in carbon pools. In the context of this Methodology, GHG removals correspond to the carbon sequestration promoted by perennial cultivation in the Agricultural Cultivation Areas.

Methodology Compliance Report (MCR): a report that describes the project's compliance with the participation criteria of the Methodology. The Methodology Compliance Report is intended to attest that the property or properties meet the requirements of the Methodology.

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[1] It should be noted that, although GHG removals are not addressed in this Methodology, this is the mechanism by which carbon sequestration is taken into account in planting activities. Broadly speaking, GHG reductions relate to the maintenance of carbon stocks in conserved forests, whilst GHG removals relate to carbon sequestration from reforestation plantations.

Methodology Compliance Report and Monitoring Report (MCRMR): this is the combination of the Methodology Compliance Report and the Monitoring Report, which may be produced in the first monitoring period, when the MCR is submitted together with the first MR.

Monitoring Report (MR): a report that describes the Monitoring, Reporting and Verification (MRV) process, the purpose of which is to attest that the EnS are being maintained or enhanced over time. It may be produced annually or at longer intervals, up to a maximum of five years.

Safety Reserve: a portion of Gross C+ (cultivation or native), segregated and not available for trading, accumulated in each monitored period, to guarantee compensation for any project reversals. This is a reserve against unforeseen events that may occur in the Woody Native Vegetation Area and the Agricultural Cultivation Area of the Project Area, which may compromise the carbon stocks within the project's boundaries, such as deforestation, fires, invasions, withdrawal, discontinuation of good agricultural practices, among others. The Safety Reserve will be released every 10 years of the project, as a fraction of the total reserve, where it has not been used in the course of the project.

Risk of Loss: factors of threat and disturbance to the maintenance of the EcS and to the provision of EnS.

Environmental Services (EnS): individual or collective activities that contribute to the maintenance, restoration or enhancement of ecosystem services (EcS).

Ecosystem Services (EcS): benefits relevant to society that are generated by ecosystems, in terms of the maintenance, restoration or enhancement of environmental conditions, in the following modalities: a) provisioning services: those that supply environmental goods or products used by humans for consumption or trade, such as water, food, timber, fibres and extracts, among others; b) supporting services: those that sustain life on Earth, such as nutrient cycling, waste decomposition, the production, maintenance or renewal of soil fertility, pollination, seed dispersal, control of populations of potential pests and potential vectors of human diseases, protection against solar ultraviolet radiation, and the maintenance of biodiversity and genetic heritage; c) regulating services: those that contribute to the maintenance of the stability of ecosystem processes, such as carbon sequestration, air purification, moderation of extreme weather events, maintenance of the equilibrium of the hydrological cycle, mitigation of floods and droughts, and control of critical erosion and slope-failure processes; d) cultural services: those that constitute non-material benefits provided by ecosystems, through recreation, tourism, cultural identity, spiritual and aesthetic experiences and intellectual development, among others.

Brazilian Greenhouse Gas Emissions Trading System (SBCE): a system established by Law No. 15,042/2024, which sets out guidelines and regulates the activities, sources and installations located within the national territory that emit or may emit greenhouse gases (GHG), under the responsibility of operators who are natural or legal persons in accordance with the said law.

4 PSA CARBON AGRO PERENE PROGRAMME GUIDELINES

The PSA Carbon Agro Perene is intended to create a systemic environment that meets (i) the need to remunerate the Provider or Producer of EnS, who generate or enhance EcS on their properties, and (ii) society's demand for the maintenance of the climatic cycle, the neutralization of GHG emissions, sustainable food production, the maintenance of biodiversity, the conservation of carbon stocks, and other benefits generated by EnS.

4.1 REGISTRATION PLATFORM

The ECCON Data platform, managed by ECCON, is used to provide transparency and to enable the storage of information. It is a database of forests, productive farms and rural properties, which enables environmental business opportunities in a scalable and replicable manner.

Areas joining the PSA Carbon Agro Perene will be registered, and the data made available on the platform, including reports, metrics of the valued EnS, Ecosystem Indicators and Agricultural Practices Indicators used in the generation and availability of C+.

Registration may also be made on another duly approved platform.

4.2 REGISTRATION OF PROJECT AREAS

Registration of areas will be carried out on the ECCON Data platform, which is online and supported by procedures designed to ensure the security of those involved. Using a login and password, the Providers or Producers of EnS access the user environment, in which they enter personal data, information and photographs of the property, and upload documents (such as: property title records, receipt of enrolment in the Rural Environmental Registry, Rural Property Registration Certificate, plans, maps, polygons, etc.).

Once all registration requirements have been provided, the property undergoes a technical analysis, which verifies compliance with the prospecting criteria and suitability for environmental business.

That analysis assesses criteria such as:

i. geographical region and biome of interest;
ii. extent;
iii. overlap with protected areas, such as indigenous lands, quilombola territories, listed heritage areas, conservation units, among others;
iv. Permanent Preservation Areas (APPs) and Legal Reserve;
v. unprotected areas suitable for reforestation projects;
vi. vegetation cover and deforestation history;
vii. surrounding communities, where applicable.

All newly registered users digitally sign a terms-of-service agreement that confirms their links with the platform. Upon passing the verification filter, the areas considered suitable are classified and published.

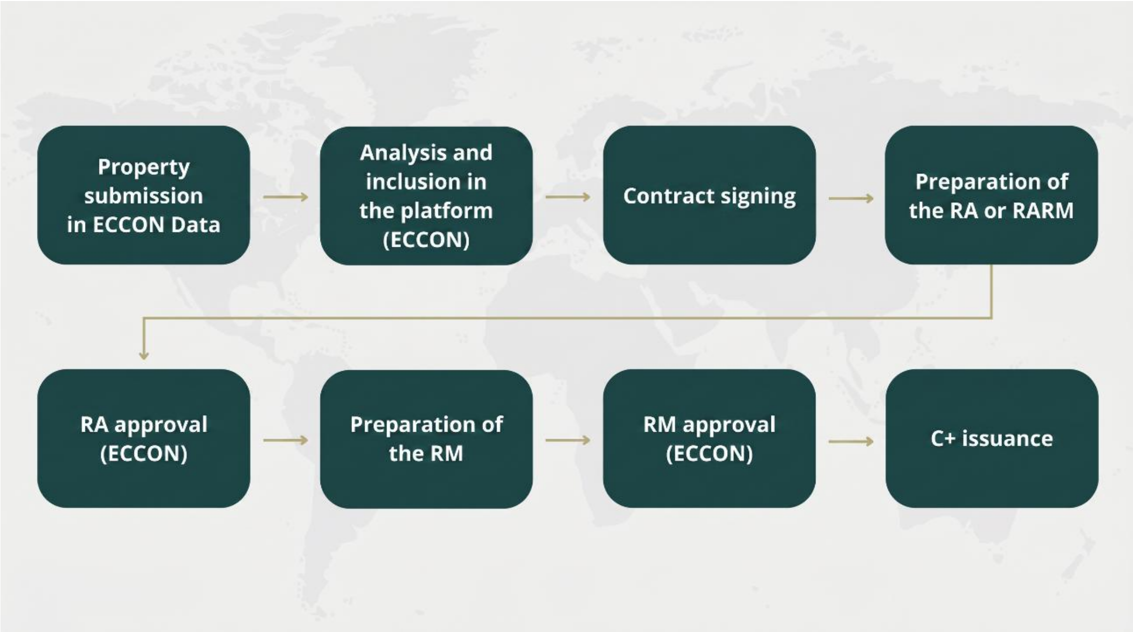
Table 1 describes the operations of the platform.

Table 1. Operations provided by ECCON Data.

Operation	Description
Global document organisation	Documents provided by the registered Providers or Producers of EnS are organised in a simple manner so that all interested parties have easy access.
Cloud document storage	The platform features cloud-based data storage, ensuring large storage capacity and organisation. In addition to offering a virtual environment better suited to securing data independently, the risks of damage to or loss of files and documents are significantly minimised.
Facilitated communication	Through a chat channel available in the user environment of the platform, it is possible to raise queries about the registration process or about environmental operations, request documents, provide data, and engage in other interactions.
Analysis of geo-referenced information	Data from the areas submitted on the platform (in kmz, shp or dwg format) enable a complete assessment of land use, supporting the analysis of compliance with the eligibility criteria for rural properties.
Geoprocessing tools	Through geoprocessing tools, it is possible to verify the biome and the characteristic vegetation physiognomy of the area. It is also possible to graphically assess the area and its potential overlap with layers of interest (embargoed areas, archaeological sites, conservation units, etc.). Geo-referencing, together with remote-sensing analysis techniques, enables a complete assessment through the application of vector and raster data provided by competent official bodies. This method enables geolocated verification of the selection criteria for rural landowners, making the property-validation process more detailed.

Providers or Producers of EnS interested in participating in the PSA Carbon Agro Perene must submit their property for analysis on the platform (Figure 2). Following their inclusion, if approval is granted by ECCON, a Term of Adherence is signed for participation in the programme. The interested party applies the Methodology to its area(s) and must prepare the Methodology Compliance Report (MCR, item 7.1). Upon approval of the report, the monitoring stage begins, at which point the Monitoring Report must be prepared (item 7.2). Following approval of the Monitoring Report, the issuance of C+ is requested. A new monitoring period then begins for the next issuance of C+, and so on throughout the life of the project.

Figure 2. PSA Carbon Agro Perene enrollment process.



4.3 ENVIRONMENTAL SERVICE PROVIDERS OR PRODUCERS

The Owners of the properties included in the PSA Carbon Agro Perene are Providers or Producers of EnS to society and will be the holders of the C+ relating to the Project Areas of their properties. Those agents have the following duties:

i. to guarantee the continuity of the provision of the EnS, which will be remunerated through the issuance of C+;
ii. to register on ECCON Data or on an equivalent duly approved platform, and to provide data such as: the name of the property, total extent of the area, extent of the area available for business, location, photographs and documents of the property, data on invasions, existence of protected areas, etc.;
iii. to guarantee and assume contractual responsibility that the property does not take part in any other PSA program or carbon project in the Project Area, thereby avoiding the risk of double counting. In the specific case of water-related PSA, managed by other entities (whether private and/or states, municipalities, etc.), it is important that the Providers or Producers of EnS indicate such participation at the time of submission of the property on ECCON Data. Where the water-related PSA does not make use of the carbon stock to generate credits, the coexistence of the PSA Carbon Agro Perene with the water-related PSA is permissible;
iv. to make available the documentation necessary for compliance with the Methodology (see item 5.13.1.2);
v. to comply with monitoring deadlines and guarantee the truthfulness of the information reported.

4.4 PAYERS FOR ENVIRONMENTAL SERVICES

The Payers for Environmental Services, or C+ Purchasers, carry out the role of remunerating the Providers or Producers of EnS who generate EcS, acting, therefore, as payers for the EnS provided.

Through the acquisition of C+, payers strengthen actions that benefit Brazilian biomes and conservationist rural producers involved in the sustainable production of perennial shrub or woody plants, thereby giving concrete expression to their contribution to the mitigation of climate change.

It is worth noting that C+ has an added value of contribution to social development, inasmuch as it introduces the Providers or Producers of EnS into the carbon market and the market for payments for environmental services, giving recognition to practices of biome conservation and good agricultural practices in the field, and may also promote the empowerment of the communities surrounding the project area, where applicable. Thus, by purchasing C+, payers support compliance with the UN's 2030 Agenda for Sustainable Development, a global action plan that provides parameters to the international community (such as the 17 Sustainable Development Goals) for improving quality of life, the conditions of the planet and the generation of prosperity.

When acquiring C+, payers will have:

- access to information on the volume of C+ and the areas to which they refer;
- transparency of information on the C+ and Project Areas;
- traceability of the EnS provided, together with the methodology and metrics used, based on the Ecosystem Indicators and Agricultural Practices Indicators;
- assurance of the quality of the EnS;
- innovation within the carbon market, in view of the pioneering proposal to create an environment for valuing EcS and constituting C+, taking into account the Brazilian context, its social and economic issues and its biodiversity.

The following legal entities are not eligible as purchasers: (a) those involved in acts in breach of Law No. 12,846/2013 (the "Brazilian Anti-Corruption Law"); (b) those included in the Register of Employers who have subjected workers to conditions analogous to slavery (the "Dirty List of Slave Labor") of the Ministry of Labor and Social Security; (c) those recognized for practices in breach of environmental legislation; and (d) those with reputational characteristics that could damage the perception of the quality of the C+.

4.5 CONTRACTUAL INSTRUMENTS

The legal relationships in the PSA Carbon Agro Perene may involve parties such as the technical and/or financial developer or co-developer, the Environmental Services Providers or Producers and the C+ purchasers. To this end, specific contracts are recommended, as set out in Table 2. It is important to emphasize that the contractual structure below is the recommended one, but there may be exceptions, as, for example, where the figures of the Financial Developer and the Environmental Services Provider or Producer coincide.

Table 2. Contractual relationships.

Instrument	Partnership Agreement[2]	Term of Adherence	Purchase and Sale Agreement[3]
Parties	Technical Developer x Financial Developer of the Project	Financial Developer x Environmental Services Provider or Producer of the Project Area, with the Technical Developer as Intervening Consenting Party, where applicable	Credit Holder x C+ Purchaser, with the Technical Developer as Intervening Consenting Party
Content	Defines the products and procedures involving the application of the PSA Carbon Agro Methodology, in a more general manner. The Agreement contemplates the possibility of application of the PSA on areas owned by the Financial Developer or by third-party EnS Providers, establishing the limits of the Financial Developer's liability in maintaining the PSA, with the areas being included by means of the Term of Adherence.	Formalizes the linking of each Area to a given PSA Carbon Agro application project, defines the rights and duties of the Parties for the maintenance of the conditions necessary for the issuance of the credits, already containing the declaration of intention to promote conservation actions and best agricultural practices, which may be used as a body of evidence to demonstrate the measures of conservation of the vegetated areas, and which serves to validate, clearly, the Area's Adherence Date to the Project, and also to establish the stages of implementation, remuneration, representations and warranties of the Environmental Services Provider or Producer; events of default; general provisions; and data and documents concerning the Project Area.	Establishes the qualification of the parties; specification of the quantity of C+ to be acquired; remuneration, price and form of payment; obligations of both Parties; events of default; term; warranties and general provisions.

[2] It should be noted that, depending on the terms agreed between the parties, the Partnership Agreement template may be replaced by a Service Agreement.

[3] With regard to the Purchase and Sale Agreement, it may be entered into between an AS Provider or Manufacturer and a Purchaser.

4.6 CARBON MARKET AND PSA CARBON AGRO PERENE

The carbon market consists of transactions of titles representative of Reductions of GHG Emissions or of carbon sequestration generated in a given project, for offsetting the Emissions arising from economic activities or compliance with voluntary commitments of entities and institutions towards combating climate change. It originated with the Kyoto Protocol[4] in 1997, which allowed organisations located in developing countries to generate Emission Reductions that could be acquired by organisations committed to reducing their Emissions in developed countries with targets established under the Protocol. Over time, other regional and national regulated markets emerged.

In parallel, we have witnessed the formation of the voluntary carbon credit market, which is on the rise in Brazil and worldwide, allowing for the participation of different sectors of the economy, covering public and private projects which, through the reduction of emissions, carbon capture or activities that prevent planned emissions, certify those results in the form of carbon credits which may be traded for the offsetting of emissions, both domestically and internationally. Among the modalities of projects are those relating to agriculture, forestry and other land uses, which contribute to the reduction of deforestation and the increase in forested areas, allowing the outcomes (materialised in carbon credits) to be transacted domestically and internationally.

The voluntary market relates to matters of corporate, social and environmental responsibility (ESG – *Environmental, Social and Governance*). Organizations seeking to acquire carbon credits to offset their emissions take part in it, not necessarily for the purposes of compliance with legal obligations or international protocols.

It is an attractive system for presenting the organization to the market as an agent aware of its necessary contribution to the transition to a low-carbon economy. It is noteworthy that organizations have also been investing in a range of environmental projects to contribute to the Reductions of Emissions, without, however, using those Reductions to offset the Emissions generated by their activities. The rise of the ESG concept and the increase of corporate responsibility have further fostered the potential of the voluntary Carbon market.

The pressure for companies to be environmentally responsible is growing on the part of their stakeholders, who give preference to investment in and purchase of products from companies that are aligned with ESG practices. Transparency and disclosure of information relating to environmental, social and governance practices are also, frequently, obligations provided for by law. In Brazil, although there are legislative gaps on the subject, it is observed that companies are increasingly being called upon to disclose information relating to ESG practices.

Regarding environmental factors, climate action has become one of the central themes on the global agenda, such that the reduction of the carbon footprint has been one of the main practices adopted by large companies in the context of their ESG agendas.

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[4] An international treaty adopted at the 3rd Conference of the Parties to the United Nations Framework Convention on Climate Change, under the United Nations Framework Convention on Climate Change, which set emission reduction targets for developed countries listed in Annex I to the Protocol.

Within the voluntary market, projects are developed in accordance with identified opportunities for the reduction or sequestration of emissions, through the application of methodologies which are, usually, validated by a third party. At the end of each project monitoring cycle, carbon credits are issued, which may be traded. In order to guarantee the high quality of the projects and of the credits generated, it is necessary to adopt mechanisms and protocols that ensure appropriate measurement and the quality and integrity of the carbon credits generated.

The carbon market and PSA form part of the sustainable finance agenda. As mentioned, in Brazil, one of the main laws that regulates and promotes the conservation of ecosystems and native vegetation is Federal Law No. 14,119/2021, which establishes the National Policy on Payment for Environmental Services (PNPSA), which is consistent with Law No. 15,042/2024, which establishes the Brazilian Greenhouse Gas Emissions Trading System (SBCE), and with Article 41 of Federal Law No. 12,651/2012 (the Brazilian Forest Code). There are, however, other initiatives aimed at remunerating Environmental Services providers in Brazil, such as the Green CPR (provided for in Federal Decree No. 10,828/2021), a security that allows the rural producer and other agents acting in the agribusiness chain to raise funds that will be directed to financing the conservation of native forests and their biomes.

The carbon market places Brazil and the natural and legal persons that join it in a highly competitive position, by virtue of the country having extensive forested and agricultural areas whose protection, conservation or enrichment may be the subject of carbon projects, by reason of the preserved and/or enhanced stock and the EcS provided. On the other hand, the country is globally prominent for its substantial agricultural production, making the agricultural sector a leading player in the Brazilian economy. With advances in technology, good agricultural practices aimed at mitigating or avoiding negative impacts on the environment are being made available and have been adopted by Brazilian rural producers. These are EnS that generate and maintain EcS and, for that reason, must be valued and recognised by society.

In addition to the high potential for generation of EcS, projects developed involving conservation and good agricultural practices can generate various social and environmental co-benefits, such as the reduction of erosion, the maintenance of local biodiversity, the improvement of water quality and availability, and positive effects on human health related to the reduction of deforestation and fires. Furthermore, such projects meet one of the guidelines of the PNPSA, which is the use of this Methodology as an instrument to promote the social, environmental, economic and cultural development of populations in rural and urban areas and of rural producers, in particular traditional communities, indigenous peoples and family farmers, among others.

The high costs of the international certification processes for carbon projects, coupled with the lack of adequate recognition of the potential of Brazilian biomes by foreign carbon methodologies, hinder the participation of many Brazilian rural producers in this market. In that context, the PSA Carbon Agro Perene, as a methodology adapted to the national reality, seeks to overcome those limitations, aiming, through the valuation of national biomes, automation and cost reduction, at the inclusion of EnS Providers or producers through the generation of carbon credits of high quality.

Accordingly, with the aim of fostering the potential for economic development, social equity and ecological balance, the PSA Carbon Agro Perene introduces EnS Providers or producers into the carbon market, strengthening and disseminating conservation and the adoption of good agricultural practices as an environmental business in Brazil. The C+ generated under the PSA Carbon Agro Perene, in accordance with the Methodology, will have pricing based on the measurement of the EcS generated for human well-being, as well as on the measurement and valuation of the good practices adopted. Finally, there is a social component (co-benefits) in the valuation of the payment, in compliance with the Agenda for Sustainable Development.

5 DEVELOPMENT OF THE METHODOLOGY

The following items set out the information necessary for understanding and applying the Methodology in eligible areas, from the analysis of the ecosystem services present in the project areas, through the Ecosystem Indicators and Agricultural Practices Indicators used to qualify the area, to the conversion into C+ (the means of payment for environmental services) and the applicable monitoring.

5.1 ECOSYSTEM SERVICES (ECS)

The PSA Carbon Agro Perene Methodology is guided by (i) the measurement of EcS generated in a given Project Area, and (ii) the measurement of the EnS relating to good agricultural practices performed in the Project Area, which maintain or contribute to the generation of EcS. EcS.

5.1.1 CLASSIFICATIONS OF ECOSYSTEM SERVICES (ECS)

This Methodology takes into account the various EcS classification systems offered by the literature. Three publications of recognised relevance may be mentioned that have contributed to the development of the understanding of the role of EcS in human well-being: MEA, TEEB and CICES.

i. MEA – Millennium Ecosystem Assessment.[5]
ii. TEEB – The Economics of Ecosystems & Biodiversity.[6]
iii. CICES – Common International Classification of Ecosystem Services.[7]

According to Costanza et al. 2017[8], "*The MEA, launched in 2001, was a predominantly ecological project under the umbrella of the United Nations Environment Programme. It took an integrated approach to assessing ecosystem services, through the participation of approximately 1,360 scientists. The TEEB, on the other hand, is a project launched in 2007, led by the UNEP, with a more economic perspective, aimed at supporting the recognition, demonstration and capture of the value of ecosystem services and biodiversity. Lastly, the CICES was launched in 2013 and is led by the European Environment Agency, with the aim of providing a hierarchical and standardised classification to support the measurement and monitoring of ecosystem services and their incorporation into environmental and economic accounts.* "

[5] Available at: https://www.millenniumassessment.org/en/index.html
[6] Available at: https://teebweb.org/
[7] Available at: https://cices.eu/
[8] Costanza, Robert; Groot, Rudolf de; Braat, Leon; Kubiszewski, Ida; Fioramonti, Lorenzo; Sutton, Paul; Farber, Steve; Grasso, Monica. Twenty years of ecosystem services: how far have we come and how far do we still need to go? Ecosystem Services, [S.L.], vol. 28, pp. 1–16, Dec. 2017. Elsevier BV. Available at: http://dx.doi.org/10.1016/j.ecoser.2017.09.008.

In addition, the Methodology is guided by the provisions of Brazilian legislation on PSA, Federal Law No. 14,119/2021, which defines four categories of EcS. EcS. Accordingly, this Methodology admits multiple EcS classification systems, allowing flexibility for each project to use the one most suited to its context.

The Table 3 below presents a brief comparison of the concepts of these four sources of EcS classification.

Table 3. EcS classifications for the PSA Carbon Agro Perene and their concepts.

	MEA (2005)	TEEB (2012)	CICES (2018)	PSA Law
Regulating	Regulation of ecosystem processes.	Services that ecosystems provide when acting as regulators.	All of the ways in which living organisms can mediate or moderate the environment.	Those that contribute to the maintenance of the stability of ecosystem processes, such as carbon sequestration, air purification, moderation of extreme weather events, maintenance of the equilibrium of the hydrological cycle, mitigation of floods and droughts, and control of critical erosion and slope-failure processes.
Supporting	Services necessary for the production of all other types of ecosystem services.	Services that sustain most of the other services.	Not recognised.	Those that sustain life on Earth, such as nutrient cycling, waste decomposition, the production, maintenance or renewal of soil fertility, pollination, seed dispersal, control of populations of potential pests and potential vectors of human diseases, protection against solar ultraviolet radiation, and the maintenance of biodiversity and genetic heritage.
Provisioning	Products obtained from ecosystems.	Services of material or energy outputs from ecosystems.	Nutritional and non-nutritional materials, and energy materials from living systems, together with abiotic materials and information.	Those that supply environmental goods or products used by humans for consumption or trade, such as water, food, timber, fibres and extracts, among others.
Cultural	Non-material benefits.	Non-material benefits obtained through contact with ecosystems.	All non-material, and generally non-rival and non-consumable, products of ecosystems (both biotic and	Those that constitute non-material benefits provided by ecosystems, through recreation, tourism, cultural identity, spiritual and aesthetic experiences and intellectual development, among others.

	MEA (2005)	TEEB (2012)	CICES (2018)	PSA Law
			abiotic) that have cultural significance for people.	

5.1.2 ECOSYSTEM SERVICES (ECS)

The Methodology directs that the developer address the classifications (see item 5.1.1) that it considers applying in the development of the PSA project, as well as indicate, in an objective manner, which of the EcS encompassed by such classifications are relevant in the Area to be analysed and may be maintained or enhanced by the EnS of the project.

As the Methodology provides for the use of multiple classifications, the proponent must summarise the EcS selected for the development of the project with the corresponding indicators.

The **Annex I. Example table of EcS derived from the CICES classification** presents an example table listing the EcS.

5.2 ECOSYSTEM INDICATORS AND ECOSYSTEM SERVICES (ECS)

The Ecosystem Indicator will be the factor used by this Methodology to characterise and attribute value to the EcS identified from the classifications referred to in the previous item. The Ecosystem Indicators may be mandatory or optional, as shown in the table below. In the case of the mandatory Ecosystem Indicators, all must be analysed for the composition of the Ecosystem Indicators Matrix; as for the optional ones, the developer may select the indicators that are most applicable to the project's context, considering the available data and the feasibility of carrying them out.

The following sections will describe: (i) the method for characterising the factors present in the Project Area that must be considered in measurements; (ii) the Ecosystem Indicators to be described based on the characteristics of the Project Area and (iii) the method for valuing EcS based on the calculated indicators.

In the event that it proves impossible to complete any of the required Ecosystem Indicators, it is necessary to provide justification. It is important to note that the list of EcS and indicators may be adjusted as the Methodology evolves, which will undergo periodic revisions.

It should be noted that the development of the project must necessarily take into account Stored Carbon, Sequestered Carbon and the other <u>six</u> mandatory Ecosystem Indicators listed in this item. The Ecosystem Indicators are:

Table 4. Ecosystem Indicators.

Theme	Ecosystem Indicator	Requirement
Carbon	Stored Carbon – Native	Mandatory
	Sequestered Carbon – Cultivation	Mandatory
Land Use and Land Cover	Native vegetation cover	Mandatory
Ecosystem Fragmentation	Structural Connectivity	Optional
	Proportionality	Optional

	Matrix Permeability	Mandatory
Permanent Preservation Areas	APP Conservation	Mandatory
Water resources	Spring Density	Optional
Biodiversity	Biodiversity (flora) Biodiversity (fauna)	Mandatory Mandatory
Sociocultural	Sociocultural impact	Mandatory

It should be noted that, when preparing the MCR (see item 7.1), the Ecosystem Indicators selected by the developer must be listed and justification provided for that choice, which must also be presented when preparing the Monitoring Reports (MR) and the Methodology Compliance Report and Monitoring Report (MCRMR) set out in items 7.2 and 7.3.

5.2.1 CARBON (MANDATORY)

The climate change already under way on the planet affects forest systems, reducing their capacity for the maintenance, restoration and enhancement of ecosystems, and thereby compromising the stocks of biomass and biodiversity. The conservation of ecosystems, together with the adoption of good agricultural practices, results in maintaining and increasing the carbon accumulated in its various pools, which contributes to reducing the concentration of CO_2 in the atmosphere.

Accordingly, the Carbon stock in the Project Area will be represented by the following Ecosystem Indicators: a) Stored Carbon, relating to the carbon stored in the Woody Native Vegetation Area; and b) Sequestered Carbon, relating to the carbon sequestered in the Agricultural Cultivation Area through the perennial crops cultivated.

5.2.1.1 STORED CARBON

To obtain the **Stored Carbon Indicator (I_{StC})**, the following steps must be taken:

i. Relate the Stored Carbon indicator to the corresponding EcS selected in item 5.1.2. Present in table format. Describe which of the listed EcS may be measured with the indicator;
ii. The analysis area for the indicator will be the Woody Native Vegetation Area (WNVA) of the Project Area, see item 5.13;
iii. Select the carbon pools, see item 5.2.1.1.1 Carbon Pools;
iv. Calculate the carbon stock estimate for each carbon pool selected for the WNVA, see item 5.2.1.1.2 Carbon Stock Estimate;
v. Obtain the total carbon stock for the WNVA, see item 5.2.1.3 Summary of carbon stock estimates;

5.2.1.1.1 CARBON POOLS

For the calculation of Stored Carbon, it is necessary to select the carbon pools to be included, according to the specific conditions of the Project Area and the data available.

Present the selection in tabular form, as per the example below (Table 5), indicating which pools are selected and providing justification for the choice of each, taking into account the relevance of the pool to the carbon stock in the region, the availability of data and the feasibility of measurement.

Table 5. Carbon pools included in the Native Vegetation Area.

Carbon Pool	Included/Excluded	Justification
Above-ground biomass	Mandatory	A pool with a large amount of carbon accumulated in the above-ground part of the vegetation, particularly in forest ecosystems.
Below-ground biomass	Mandatory	In some biomes, such as the Cerrado, the carbon stored in the below-ground part has a greater accumulation of carbon than the above-ground part.
Litter	Optional, where required and/or where acceptable secondary data are available.	Insert justification for including the pool.
Dead wood	Optional, where required and/or where acceptable secondary data are available.	Insert justification for including the pool.
Soil	Optional, where required and/or where acceptable secondary data are available.	Insert justification for including the pool.

5.2.1.1.2 CARBON STOCK ESTIMATE

The total carbon stock, for the reference year "*ti*", is calculated as the sum of the biomass pools included for the Native Vegetation Area (NVA) (see 5.2.1.1.1 Carbon Pools), in accordance with the analysis presented in the following items (Equation 1 and Table 6).

Equation 1. Estimation of carbon stock in Native Vegetation Areas.

$$C_{veg,ti} = C_{tree,ti} + C_{DW,ti} + C_{Li,ti} + C_{SOC,ti}$$

Table 6. Parameters of the Carbon Stock estimation equation.

$C_{veg,ti}$	=	Carbon stock in the biomass of trees in the Woody Native Vegetation Area in year *ti*; tCO_2e
$C_{tree,ti}$	=	Total tree carbon stock in the Woody Native Vegetation Area in year *ti*; t CO_2e
$C_{DW,ti}$	=	Carbon stock in the biomass of dead wood in the Woody Native Vegetation Area in year *t*; tCO_2e
$C_{Li,ti}$	=	Carbon stock in the biomass of litter in the Woody Native Vegetation Area in year *ti*; tCO_2e
$C_{SOC,ti}$	=	Stock of soil organic carbon in the Woody Native Vegetation Area in year *ti*; tCO_2e

It is emphasized that only the pools selected by the developer enter into the calculation of the carbon stock, and it must be clearly stated which pools have been included or excluded, together with appropriate justification. To ensure the integrity and comparability of the carbon stock estimates across different monitoring periods, it is essential that the selection of pools, once defined and justified, is maintained consistently throughout the project's duration. In the event that the developer wishes to make changes to the set of pools adopted — whether to include additional pools or to exclude previously considered ones — such modification must be preceded by a formal request for methodological adaptation (see item 5.14), which will be assessed by ECCON.

5.2.1.1.3 BIOMASS DATA COLLECTION

For the estimation of the carbon stock in the included pools, the data must be obtained from the sources set out in Table 7.

Table 7. Guidance for biomass data collection.

Biomass Data Collection	
Primary Data Collection	Forest inventory and/or combined with remote sensing;
Secondary Data Collection	i. Existing data applicable to the local situation (data available in the literature, relating to peer-reviewed scientific studies, articles, theses and dissertations with a similar ecosystem); ii. National data (for example, from the national forest inventory or the national greenhouse-gas emissions inventory)[9]; iii. Data from neighboring countries with similar conditions; iv. Data of global application.

It is emphasized that any method used for biomass data collection must be duly supported by scientific references and should consider the representativeness of the sample for the area analyzed, to ensure the reliability of the estimates.

5.2.1.1.4 ESTIMATION OF CARBON STOCK IN TREE BIOMASS ($C_{TREE,TI}$)

Tree biomass is a representative component of the total biomass stock, in both native vegetation and cultivation areas. The estimation of the carbon stock in tree biomass may be carried out using different methodological approaches, such as the use of primary data obtained through a forest inventory, the use of secondary data referenced in the scientific literature, or the use of growth and yield models.

To assess the Stored Carbon in the WNVA, the developer is directed to select the correct methodology to estimate the carbon stock, which may be either primary data collection in situ of the carbon stock, or the use of reliable secondary data. The applicable methods are presented below.

The developer is recommended to assess technically the conditions of the vegetation that characterises the WNVA and the availability of data for the chosen method, in order to avoid the collection in situ becoming a limiting factor for carrying out the project.

The developer who opts for the use of a forest inventory may not change the method of obtaining the estimate throughout the project.

[9] Brazil. Ministry of Science, Technology and Innovation. Secretariat for Scientific Research and Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change / Secretariat for Scientific Research and Training. Brasília: Ministry of Science, Technology and Innovation, 2021. 620 p. ISBN: 978-65-87432-18-2.

5.2.1.1.4.1 FOREST INVENTORY

Under this method, the carbon stock estimate may be carried out by means of a forest inventory through a census (where all trees in the population are measured) or sampling (by means of sample plots representative of the population). Sample plots must be allocated to one or more strata (for example, vegetation physiognomy types). As regards the sampling system, the eligible options for data collection are set out in Table 8.

Table 8. Suggested sampling processes and methods for the sampling design, in single and multiple occasions.

	Sampling Process	Sampling method
Single occasion	Random sampling Systematic sampling Mixed sampling	Fixed area Variable area
Multiple occasions	Independent sampling Sampling with full replacement Double sampling Sampling with partial replacement	

In the MCR and MR, the sampling system and the variables measured must be clearly presented, together with the calculations performed and the technical supporting documentation. Stratification of the area is recommended whenever there is spatial variability in the carbon stock of the vegetation, in order to ensure greater accuracy in the estimates.

The stratification of the area is recommended whenever there is spatial variability in the carbon stock of the vegetation, to ensure greater accuracy in the estimates. Each stratum must be treated independently in the sampling design, with specific sample plots for each, allowing the variability within each stratum to be captured and represented in the final estimate.

Set out below are the steps to be followed for estimating the carbon stock in tree biomass using the forest inventory method:

Step 1: In the forest inventory, measure, using appropriate dendrometric instruments, the dimensions of the sample trees (such as the diameter at breast height — DBH — and the total height) in the sample plots, following standardized protocols to ensure the quality and comparability of the data.

Step 2. For the estimation of the carbon in the biomass, select or develop an appropriate allometric equation for the vegetation type and the region of the project, ensuring that the equation was developed for conditions similar to those of the Project Area and that its parameters have been duly validated. The allometric equation must meet the following criteria:

i. The equation selected is derived from governmental sources (for example, the national forest inventory) or from peer-reviewed scientific publications;
ii. The equation, at individual tree level, was fitted on the basis of at least 30 trees sampled, with a suitable diameter distribution, and the coefficient of determination ($R_{adj.}$) obtained was not less than 0.70.

Step 3. Determine the value of above-ground and below-ground biomass per plot, in hectares, and the mean biomass stock per hectare, for each stratum considered, using the equations and parameters presented below:

Equation 2. Estimation of total tree biomass per hectare in each sample plot.

$$B_{t,p,i} = \left(\sum_{l}^{p} \left(AGB_{l,p,i} \right) * (1 + R) \right) * \frac{1}{a}$$

Equation 3. Estimation of the mean total tree biomass stock per hectare.

$$B_i = \frac{\sum Bt_{p,i}}{n_i}$$

Where:

Table 9. Parameters of the sample plot method equations.

$B_{t,p,i}$	=	Total above-ground and below-ground tree biomass in sample plot p of stratum i; in t ha^{-1}
$AGB_{l,p,i}$	=	Above-ground biomass of tree l, in sample plot p of stratum i; in tonnes (t)
R	=	Root-to-shoot ratio, obtained from secondary data similar to the characteristics of the vegetation of the Project Area;
a	=	Area of the sample plot in stratum i; ha
B_i	=	Mean above-ground and below-ground tree biomass stock per hectare in stratum i; t ha^{-1}
n_i	=	number of sample plots in stratum i

Step 4. Determine the mean carbon stock, per hectare, in the trees for each stratum considered, and the total carbon stock in the tree biomass of the Native Vegetation Area. The equations and parameters below must be used:

Equation 4. Estimation of the mean equivalent carbon stock in tree biomass, per hectare, in stratum i.

$$C_i = Bi * CF * \frac{44}{12}$$

Equation 5. Estimation of the total equivalent carbon stock in tree biomass of the Native Vegetation Area.

$$C_{tree} = \sum (A_i * C_i)$$

Where:

Table 10. Parameters for the tree carbon estimation equation.

C_i	=	Mean stock of CO_2 equivalent per hectare of trees for stratum i, in t CO_2e ha^{-1}
CF	=	Carbon fraction of tree biomass; tC. A default value of 0.47 must be used.
$\frac{44}{12}$	=	Factor for the equivalence of Carbon to equivalent Carbon Dioxide (CO_2e).
C_{tree}	=	Total tree carbon stock in the Woody Native Vegetation Area in year *ti*; t CO_2e
A_i	=	Area of stratum i, in ha

5.2.1.1.4.2 ESTIMATION THROUGH SECONDARY DATA

The carbon stock may also be estimated by means of secondary data, where the forest inventory in situ becomes a limiting factor for carrying out the project. Only secondary data derived from peer-reviewed scientific publications, governmental sources or recognized international databases may be used, provided that they are representative of the conditions of the Project Area and are duly referenced.

For the calculation of the carbon stock in tree biomass, Steps 3 and 4 described above must be followed, using the secondary data obtained in place of the primary data from the forest inventory. The justification for the use of secondary data and their representativeness for the Project Area must be presented in detail in the MCR and MR.

5.2.1.1.4.3 ESTIMATION BY GROWTH AND YIELD MODELLING

This method is applicable for the projection of the carbon stock in tree biomass by means of mathematical models that describe the growth and yield of the vegetation over time. The models used must be calibrated for the characteristics of the vegetation and of the region of the project and duly validated with primary or secondary data.

An additional approach consists of employing growth rates such as, for example, the mean annual increment (MAI, in t $ha^{-1}.year^{-1}$), derived from peer-reviewed sources (scientific articles, theses, dissertations, etc.), to estimate the carbon stock accumulated over a given period. The choice of method must be justified and the parameters used must be presented in a transparent and verifiable manner.

5.2.1.1.5 ESTIMATION OF CARBON STOCK – LITTER ($C_{LI,TI}$)

The carbon pool stored in litter may only be considered where the litter biomass is maintained *in situ* and is not removed from the boundaries of the WNVA by any type of anthropogenic activity.

Conservatively, for all strata, the equivalent carbon stock in the litter will be estimated as a fraction of the total tree carbon stock, using the following equation:

Equation 6. Estimation of the equivalent carbon stock in litter.

$$C_{Li,ti} = DF_{Li} * C_{tree,ti}$$

Where:

Table 11. Parameters for the litter carbon stock equation.

$C_{SE,ti}$	=	Carbon stock in litter biomass in the Woody Native Vegetation Area, in year ti; t CO_2e
DF_{Li}	=	Conservative factor expressing the Carbon stock in litter as a percentage of 1% of the total tree carbon stock in the Woody Native Vegetation Area[10];
$C_{tree,ti}$	=	Total tree carbon stock in the Woody Native Vegetation Area in year *ti*; t CO_2e

Other expansion factors may be applied, provided that they are duly justified and referenced.

5.2.1.1.6 ESTIMATION OF CARBON STOCK – DEAD WOOD ($C_{DW,TI}$)

The carbon pool stored in dead wood may only be considered where the dead wood biomass is maintained *in situ* and is not removed from the boundaries of the WNVA by any type of anthropogenic activity.

Conservatively, for all strata, the equivalent carbon stock in the dead wood must be estimated as a fraction of the total tree carbon stock, using the following equation:

Equation 7. Estimation of the equivalent carbon stock in dead wood.

$$C_{DW,ti} = DF_{DW} * C_{tree,ti}$$

Where:

Table 12. Parameters for the dead wood carbon stock equation.

$C_{DW,t}$	=	Carbon stock in dead wood biomass in the Woody Native Vegetation Area, in year ti; t CO_2e
DF_{DW}	=	Conservative factor expressing the carbon stock in dead wood as 1% of the carbon stored in the tree biomass of the Woody Native Vegetation Area[11]; per cent
$C_{tree,ti}$	=	= Total tree carbon stock in the Woody Native Vegetation Area in year *ti*; t CO_2e

A different value for the default factor DF_{DW} may be applied, provided that it is justifiable and presented in a transparent and verifiable manner.

5.2.1.1.7 ESTIMATION OF SOIL ORGANIC CARBON STOCK ($C_{SOC,TI}$)

[10] A/R Methodological Tool. Estimation of carbon stocks and changes in carbon stocks in dead wood and litter in A/R CDM project activities. Version 03.1. UNFCCC. Available at: https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v3.1.pdf

[11] A/R Methodological Tool. Estimation of carbon stocks and changes in carbon stocks in dead wood and litter in A/R CDM project activities. Version 03.1. UNFCCC. Available at: https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v3.1.pdf .

For the WNVA, the soil organic carbon (SOC) stock, to a depth of 30 cm, may be obtained conservatively by applying the SOC value under primary vegetation, for each of the soil-vegetation associations described in under primary vegetation, for each of the soil-vegetation associations described in Table 15[12].

Reference should be made to Table 13 and to Table 14 below in order to identify the vegetation and soil categories, so as to obtain the soil-vegetation association and the corresponding carbon stock.

Evidence and justification must be provided for the choice of soil and vegetation categories consistent with the characteristics of the Project Area, with reference to official databases, soil maps and vegetation surveys.

[12] Brazil. Ministry of Science, Technology and Innovation. Secretariat for Scientific Research and Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change / Secretariat for Scientific Research and Training. Brasília: Ministry of Science, Technology and Innovation, 2021. 620 p. ISBN: 978-65-87432-18-2.

Table 13. Categories of aggregated vegetation classes in the national territory, adapted from Brasil, 2025[13].

Vegetation Categories	
V1	Open Amazon Forest
V2	Dense Amazon Forest
V3	Atlantic Forest
V4	Deciduous Seasonal Forest
V5	Semi-deciduous Seasonal Forest
V6	Mixed Ombrophilous Forest
V7	Southern Savanna
V8	Amazonian Savanna
V9	Cerrado
V10	Southern Steppe
V11	Caatinga
V12	Pantanal
V13	Ecological Refuges of Mountains and Highlands
V14	Pioneer Formation Areas
V15	Sandy Areas and Oligotrophic Woody Vegetation of Wetland Areas

Table 14. Categories of aggregated soil classes in the national territory, adapted from Brasil, 2024[14].

Soil categories	
S1	Soils with high-activity clay
S2	Latosols with low-activity clay
S3	Non-Latosols with low-activity clay
S4	Sandy soils
S5	Hydromorphic soils
S6	Other Soils

The carbon stock values presented in Table 15 correspond to the median values presented by Brasil, 2024[15].

Table 15. Soil carbon stock by soil-vegetation association.

Vegetation Categories	Soil categories					
	S1	S2	S3	S4	S5	S6
	SOC tC ha^{-1}					
V1	50,9	47,5	48,9	41,1	43,6	78,7
V2	32,2	51,9	46,9	50,6	52,7	48,1

[13] Brazil. Ministry of Science, Technology and Innovation. Secretariat for Scientific Research and Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change / Secretariat for Scientific Research and Training. Brasília: Ministry of Science, Technology and Innovation, 2021. 620 p. ISBN: 978-65-87432-18-2.

[14] Brazil. Ministry of Science, Technology and Innovation. Secretariat for Scientific Research and Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change / Secretariat for Scientific Research and Training. Brasília: Ministry of Science, Technology and Innovation, 2021. 620 p. ISBN: 978-65-87432-18-2.

[15] Brazil. Ministry of Science, Technology and Innovation. Secretariat for Scientific Research and Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change / Secretariat for Scientific Research and Training. Brasília: Ministry of Science, Technology and Innovation, 2021. 620 p. ISBN: 978-65-87432-18-2.

Vegetation Categories	Soil categories					
	S1	S2	S3	S4	S5	S6
	SOC tC ha^{-1}					
V3	58,3	52,3	42,9	63,3	35,8	417,8
V4	46,7	30,8	40,0	25,9	32,7	31,8
V5	40,9	44,3	37,4	27,0	53,6	31,6
V6	98,8	102,5	56,8	0,0	85,4	0,0
V7	64,2	90,9	51,6	0,0	74,2	32,8
V8	48,0	19,8	38,1	43,7	34,6	29,0
V9	24,4	43,1	36,0	19,2	66,5	32,9
V10	66,0	46,6	61,2	0,0	33,8	49,9
V11	24,2	25,8	26,2	15,1	25,1	20,9
V12	33,8	0,0	35,2	35,4	105,2	21,7
V13	34,1	50,4[1]	39,9	0,0	0,0	0,0
V14	73,0	41,3[1]	33,1	50,2	59,2	37,2
V15	50,9[2]	46,8	48,1	61,7	90,5	120,9

(1) Single value reported (2) See the particularities described in Brasil, 2024.

Conservatively, for all strata, the soil organic carbon stock is estimated as the product of the median SOC under primary vegetation by the area of the stratum, converted into equivalent CO2, using the equation below:

Equation 8. Estimation of the organic carbon stock in the soil.

$$C_{SOC,veg,ti} = SOC * A * 3{,}67$$

Where:

Table 16. Parameters for the soil carbon estimation equation.

$C_{SOC,veg,ti}$	=	Total soil organic carbon stock in the Woody Vegetation Area, in year ti; t CO_2e
SOC	=	Conservative value expressing the median value of the Soil organic carbon stock by soil-vegetation association, according to Brasil, 2024; t C ha^{-1}
A	=	Area of stratum i; ha

Other methods for obtaining the soil organic carbon stock must follow the parameters of item 5.14 Methodological adaptations.

5.2.1.2 SEQUESTERED CARBON

To obtain the **Sequestered Carbon Indicator (I_{Sec})**, the following steps must be taken:

i. Relate the Sequestered Carbon indicator to the corresponding EcS selected in item 5.1.2. Present in table format. Describe which of the listed EcS may be measured with the indicator;
ii. Present the analysis areas of the indicator, which must be the Agricultural Cultivation Area of the Project Area, see item 5.13;

iii. Calculate the carbon sequestration estimate for each carbon pool for the Agricultural Cultivation Area, see item 5.2.1.2.1 Carbon Pools;
iv. Obtain the total carbon sequestration for the Agricultural Cultivation Area during the monitored period, see item 5.2.1.2.2 Carbon Sequestration Estimate.

5.2.1.2.1 CARBON POOLS

For the calculation of Sequestered Carbon, it is necessary to consider the mandatory carbon pools, presented in the table below. These pools must be considered in the estimation of the carbon sequestration in the Agricultural Cultivation Area, with justifications for their inclusion being presented in the MCR and MR.

Table 17. Carbon pools included in the Agricultural Cultivation Area.

Carbon Pool	Category	Justification
Above-ground biomass	Mandatory	A pool with a high carbon content accumulated in the above-ground part of the agricultural crops, particularly in perennial woody crops, which represent a significant stock of carbon sequestered from the atmosphere.
Below-ground biomass	Mandatory	The below-ground carbon stock is significant in relation to the total carbon of the tree, with both pools being crucial for the estimation of total carbon in perennial agricultural crops.

5.2.1.2.2 CARBON SEQUESTRATION ESTIMATE

The total carbon sequestration, in the Agricultural Cultivation Area, must be estimated as the difference between the carbon stock in the monitoring year and the carbon stock in the reference monitoring year, using the following equation:

Equation 9. Estimation of total carbon sequestration in Agricultural Cultivation Areas.

$$C_{agr,pi} = C_{tree,ti} - C_{tree,tr}$$

Where:

Table 18. Parameters of the Carbon Stock estimation equation.

$C_{agr,pi}$	=	Carbon sequestration in total biomass in the Agricultural Cultivation Area in period *pi*; tCO_2e
$C_{tree,ti}$	=	Total carbon stock in the Agricultural Cultivation Area in monitoring year *ti*; $t\ CO_2e$
$C_{tree,tr}$	=	Total carbon stock in the Agricultural Cultivation Area in the reference monitoring year *tr*; $t\ CO_2e$

In the calculation of the carbon sequestered in the Agricultural Cultivation Area, two distinct scenarios may exist:

- an initial scenario in which there is no clear-cutting during the valuation period, associated with the renewal of the crop after the end of the valuation period;
- a second scenario, in which clear-cutting is carried out periodically throughout the project.

The accounting of the sequestered carbon will depend directly on the dynamics of the crop management, as detailed below.

Cultivation Scenario without Clear-cutting

In this scenario, there is no periodic cutting for the renewal of the crop; that is, all of the carbon accumulated in the biomass of the perennial crop is maintained over the entire valuation period. The carbon sequestration must be calculated as the accumulation of carbon stock over time, using Equation 10.

Equation 10. Total carbon sequestration in Agricultural Cultivation Areas.

$$Sequestered\ Carbon = \sum C_{agr,i,valuation\ period}$$

Where:

Table 19. Parameters of the Sequestered Carbon estimation equation.

$Sequestered\ Carbon$	=	Total carbon sequestration in the Agricultural Cultivation Area during the valuation period; tCO_2e
$C_{agr,i,valuation\ period}$	=	Total carbon sequestration in year *i* of the valuation period; tCO_2e

Cultivation Scenario with Clear-cutting

Where periodic clear-cutting is carried out for the renewal of the cultivation areas, part of the carbon stored in the biomass is removed at each cutting, and the sequestration dynamics therefore differ from the previous scenario.

To ensure the integrity of the credits generated in that scenario, the sequestration must be estimated as the Mean Carbon Benefit (MCB) over the valuation period, using the equation below:

Equation 11. Mean Carbon Benefit for productive scenarios with clear-cutting.

$$MCB = \frac{\sum C_{tree,valuation\ period}}{Valuation\ Period + 1}$$

Table 20. Parameters of the Carbon Stock estimation equation.

MCB	=	Mean carbon sequestration in biomass in the Agricultural Cultivation Area during the valuation period; tCO_2e
$C_{agr,valuation\ period}$	=	Total carbon sequestration in biomass in the Agricultural Cultivation Area during the valuation period; tCO_2e

In this case, the sequestered carbon will be equivalent to the MCB, given the periodic removal of the accumulated carbon. The accounting of the carbon sequestration in this scenario will be carried out as set out in Equation 12).

Equation 12. Accounting for Sequestered Carbon in productive scenarios with clear-cutting.

$$Sequestred\ Carbon = MCB$$

Table 21. Parameters of the Carbon Stock estimation equation.

MCB	=	Mean carbon sequestration in biomass in the Agricultural Cultivation Area during the valuation period; tCO_2e

5.2.1.2.3 BIOMASS DATA COLLECTION

The carbon sequestration estimate in the Agricultural Cultivation Area may be carried out on the basis of primary data obtained in situ, see item 5.2.1.1.4.1 Forest inventory. In the estimation by secondary data, the developer must follow the criteria required in item 5.2.1.1.4.2.

5.2.1.3 SUMMARY OF CARBON STOCK ESTIMATES

The developer must present the summary of the results of the carbon estimates for the Project Area, consolidating the values of Stored Carbon in the WNVA and of Sequestered Carbon in the Agricultural Cultivation Area. The summary must be presented in tabular form, with the values of the carbon stock and the carbon sequestration for each analysis area, and with the total value of the Carbon Indicator for the Project Area, expressed in tCO_2e and per ha of the Project Area.

5.2.2 NATIVE VEGETATION COVER (MANDATORY)

Land-use and land-cover analysis provides information on the types of environments and habitats within a given area, enabling, from an ecological perspective, the assessment of the potential provision of ecosystem services. Although coverage by native vegetation does not, on its own, guarantee the provision of the EcS, its presence is an essential indicator of the conservation of ecosystems and of the maintenance of biodiversity, which are fundamental for the provision of the EcS.

For that reason, this Methodology assesses the land use and land cover in the Project Area, with its different types of vegetation and land use, considering the proportion of native vegetation in relation to the total area of the property and the Area of Influence.

For the calculation of the **Native Vegetation Cover Indicator**:

i. Relate the Native Vegetation Cover indicator to the corresponding EcS selected in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicators;
ii. The analysis area of the indicator is the Area of Influence, taking into account the buffer and the rural properties of the Project Area, see item 5.13.
iii. Obtain the classes of wooded and/or forested vegetation, or other types of native vegetation, which are representative of the region, from secondary data bases of recognised quality.
iv. The calculation of native vegetation cover may be surveyed for each property area, by means of geoprocessing analyses, using the operation *intersect* between the classes of vegetated areas and the areas of the surveyed properties, and, for the vegetated areas of the Project Area, the Total Native Vegetation Area (TNVA) must be considered.
v. Obtain the percentage of cover with native vegetation (%), calculated by dividing the TNVA on the property by the total area of the property.
vi. Assign scoring in accordance with the table below:

vii. Ecological value and characterization of the indicators must be assigned in accordance with their importance in ecosystem conservation, with scoring based on the percentage of native vegetation cover on the property.

Table 22. Scoring for the native vegetation cover indicator.

Indicator	Description	Score
Percentage of Cover of Native Vegetation (CVN)	CVN ≤ 20%	1
	20% < CVN ≤ 40%	2
	40% < CVN ≤ 60%	3
	60% < CVN ≤ 80%	4
	80% < CVN ≤ 100%	5

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.2.3 ECOSYSTEM FRAGMENTATION

Deforestation and the conversion of native vegetation areas to other land uses cause fragmentation of natural habitats, resulting in the loss of biodiversity and the impairment of the ecological functions of ecosystems[16].

The loss of those habitats generates environmental imbalance with numerous impacts, such as the reduction of populations of native species, the loss of genetic diversity, the alteration of ecosystem processes, and the impairment of the provision of ecosystem services.

It is important to highlight the processes that interfere with the structure of the landscape and may be considered in the assessment of ecosystem fragmentation:

i. Connectivity and isolation;
ii. Size and shape of the fragment;
iii. Edge effect;
iv. Mean isolation.

To assess fragmentation and its associated indicators, Geographic Information System (GIS) tools must be used, with remote-sensing data and land-use and land-cover maps, which allow the spatial structure of the landscape to be analyzed and the metrics of ecosystem fragmentation to be calculated.

In the subsequent items, three indicators are assessed which address the fragmentation of ecosystems in the Project Area, namely: structural connectivity, proportionality and matrix permeability. Those indicators are complementary and allow a comprehensive assessment of the fragmentation of ecosystems, considering different aspects of the spatial structure of the landscape.

[16] Wilcove et al. 1986, cited in Hentz et al., 2015. Available at: https://www.conhecer.org.br/enciclop/2015b/multidisciplinar/avaliacao%20da%20fragmentacao.pdf

5.2.3.1 STRUCTURAL CONNECTIVITY

The functionality of an ecosystem depends, in part, on the ability of animals to move between habitats, which is directly linked to the landscape's connectivity. The spatial distribution of vegetation is important for creating habitats, maintaining connectivity between areas and enabling the flow of organisms, energy and nutrients through the landscape[17].

Interconnected areas have high connectivity, whereas areas with isolated fragments have low connectivity[18, 19, 20].

The provision of ecosystem services responds to the landscape's connectivity, modifying and contributing to the balance of natural systems[21], and for that reason, this Methodology takes into account the Structural Connectivity of the landscape as a priority Ecosystem Indicator for the assessment of ecosystem fragmentation.

To assess the connectivity between vegetation fragments within the Area of Influence, the Proximity Index is used, which considers the distance between fragments and their sizes, providing a quantitative measure of connectivity.

Accordingly, this Methodology uses the proximity index as an indication of the connectivity between native vegetation fragments within the Area of Influence of the project, as illustrated in (Figure 3).

The index is more appropriate for the assessment of "high-contrast" landscapes, where there is a clear distinction between habitats and the surrounding matrix, allowing a more accurate analysis of the ecological connectivity between native vegetation fragments.

Figure 3. Illustration of how the proximity index works.

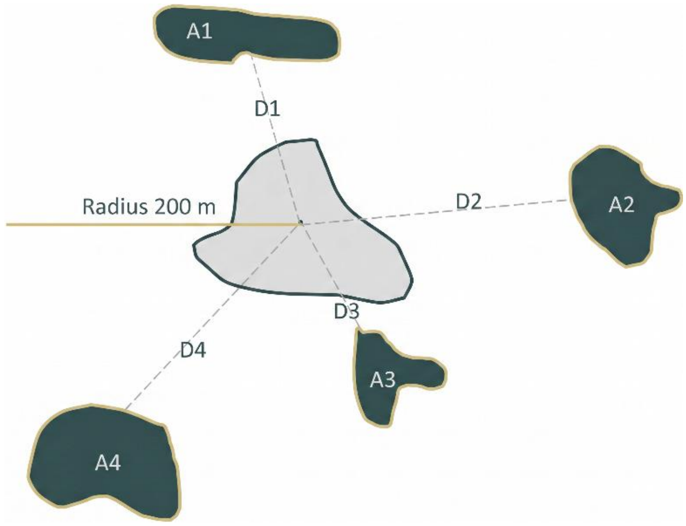
[17] See: Bennet, A. F. 'Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation'. IUCN, Gland, Switzerland, and Cambridge, UK. XIV + 254 pp., 1999.

[18] See: Andrèn, H. Effects of habitat fragmentation on birds and mammals in landscapes with different proportions of suitable habitat: a review. Oikos, vol. 71, no. 3, pp. 355–366, Dec. 1994.

[19] See: Metzger, J. P.; Décamps, H. The structural connectivity threshold: a hypothesis in conservation biology at the landscape scale. Acta Ecologica, vol. 18, pp. 1–12, 1997.

[20] See: Pardini, R. et al. The role of forest structure, fragment size and corridors in maintaining small mammal abundance and diversity in an Atlantic Forest landscape. Biological Conservation, 124: 253–266, 2005.

[21] See: Mitchell, M.G.E., Bennett, E.M., Gonzalez, A. Linking Landscape Connectivity and Ecosystem Service Provision: Current Knowledge and Research Gaps. Ecosystems, 894–908, 2013.



F (1, 2, 3 and 4) = Fragments identified; D (1, 2, 3 and 4) = Distance between the fragments.

The proximity value is calculated using the area (A_i)) and the edge-to-edge distance of the patch to the nearest neighbouring forest patch (D_i) of each of the forest patches identified within the buffer, including the patch being analysed. The result is a value that expresses the proximity between fragments, allowing the landscape's connectivity to be assessed.

Equation 13. Proximity Index.

$$PROX = \sum_{i=1}^{n} \frac{A_i}{D_i}$$

Where:

Table 23. Parameters for the Proximity Index equation.

$PROX$	=	Proximity Index
n	=	Number of fragments
A_i	=	Area of the fragments
D_i	=	Edge-to-edge distance from the indexed fragment to the nearest neighbouring fragment

Thus, in Figure 3, the calculation of the proximity index of a single forest patch (Indexed Area) considers the buffer and the distance to neighbouring fragments. In the example, fragments 1, 3 and 4 are within the buffer and are used in the calculation of *Prox*., whereas fragment 2 is not used, as it lies entirely outside the proximity buffer. In this way, the proximity index reflects the connectivity of the indexed fragment with its neighbours within the defined buffer radius.

Accordingly, to obtain a **Structural Connectivity Indicator,** the Methodology requires:

i. Relating the Structural Connectivity indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;

ii. The analysis area of the indicator must be composed of the TNVA and the area mapped in the buffer of the Area of Influence, see item 5.13.
iii. It is suggested that three distinct radii be used for the testing (200 m, 500 m and 1,000 m) for each scenario, so that the connectivity is assessed at different scales;
iv. Obtain the proximity index for the Area of Influence for the following scenarios:
    a. *Scenario 1*: considering the native vegetation fragments in the Project Area; and
    b. *Scenario 2*: absence of the Project Area (simulating that there is no native vegetation in the Project Area).
v. Test the proximity index (above) with the selected radii in the two scenarios described, and compare the results to identify the contribution of the Project Area to the connectivity of the landscape.
vi. To ensure spatial comparability between the scenarios, a spatial *intersect* must be carried out between the features resulting from Scenarios 1 and 2, so as to identify exclusively the areas of change in connectivity attributable to the Project Area.
vii. After analysing the proximity between fragments, the values obtained must be divided into connectivity classes (very low, low, medium, high and very high), on the basis of the distribution of the proximity values observed in the Area of Influence.
viii. To obtain the score of the indicator, the number of fragments in each connectivity class must be counted for Scenarios 1 and 2, and the increase in the "very high" connectivity class in Scenario 1 in relation to Scenario 2 calculated.

The following table provides the distribution of the indicator score on the basis of the comparative analysis between Scenarios 1 and 2:

Table 24. Scoring for the connectivity indicator.

Indicator	Description	Score
Variation in Connectivity (Con)	Increase of up to 5% in the "very high" class	1
	Increase of up to 20% in the "very high" class	2
	Increase of up to 40% in the "very high" class	3
	Increase of up to 60% in the "very high" class	4
	Increase of up to 80% in the "very high" class	5

It is emphasised that:

- In the case of highly conserved and connected landscapes, the removal of a parcel of native vegetation is often not sufficient to change the connectivity class of the remaining fragments, which may result in a low score for the indicator. In such cases, the developer must present a detailed justification for the value obtained and the applicable scoring.
- Cartographic products must be presented in an appropriate form to illustrate the scenarios considered.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.
- For the execution of this index, the mapping of forest formations of the Area of Influence must be used, ensuring consistency with the land-use and land-cover mapping used in the other indicators of this Methodology.

5.2.3.2 PROPORTIONALITY

To characterize the fragments found in the Project Area and in its surroundings in terms of size, this Methodology adopts the Proportionality indicator, which assesses the size of the native vegetation fragments and their contribution to the conservation of ecosystems.

To obtain the **Proportionality Indicator**:

i. Relate the Proportionality indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Area of Influence, considering the buffer and the rural properties of the Project Area, see item 5.13;
iii. With the support of GIS tools, obtain the number of fragments that make up the TNVA and the native vegetation in the Area of Influence, classifying them by size in accordance with the table below;
iv. Assign a score to the Project Area in accordance with the table below.
v. Assign ecological value to the classes of fragments, relating edge effect, shape, size and connectivity, to characterize the importance of the indicator in the scenario of the project.

Table 25. Scoring for the proportionality indicator.

Indicator	Description	Score
Proportionality (Prop) (justify the classification)	Very small (≤ 50 ha)	1
	Small (> 50 and ≤ 100 ha)	2
	Medium (> 100 and ≤ 150 ha)	3
	Large (> 150 and ≤ 200 ha)	4
	Very large (≥ 200 ha)	5

It is emphasised that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.
- For this indicator, the same rigor in the use of data must be followed as that required for obtaining the native vegetation cover (see item 5.2.2).
- If reclassification of the fragment sizes is necessary, the method used and the criteria for reclassification must be justified.

5.2.3.3 MATRIX PERMEABILITY (MANDATORY)

The fragmentation of an ecosystem gives rise to a reduction in connectivity and consequent environmental imbalance, as discussed in item 5.2.3. In this sense, the understanding of how species are affected by the other components of the landscape, in addition to the fragments of native vegetation, is fundamental for the assessment of the quality of the habitat and of the connectivity of the landscape.[22].

In this Methodology, land-use and land-cover matrix is understood to be the set of areas surrounding the fragments of native vegetation that, although they do not have the ecological characteristics of the natural ecosystems, may influence the connectivity and the permeability of the species between the fragments.[23].

In the past, land-use and land-cover matrices were frequently associated with areas of low ecological quality and of little importance for the conservation of biodiversity. However, more recent studies have shown that the structure and composition of those matrices can significantly influence the connectivity of the landscape and the provision of ecosystem services, justifying their inclusion in the assessment of ecosystem fragmentation[22].

The permeability of species, that is, their ability to use and move through the land-use and land-cover matrix[22], will depend on the degree of similarity between the land-use and land-cover matrix and the natural ecosystems of the region, as well as on the quality of the habitat and the connectivity of the landscape[22].

At present, land-use and land-cover large-scale commercial agriculture matrices are identified as the main precursors of ecosystem fragmentation and of the loss of biodiversity in tropical regions[24]. On account of their importance in the structuring of the landscape and their consequent influence on the conservation of biodiversity, this Methodology takes into account the Matrix Permeability as a mandatory Ecosystem Indicator.

The **Matrix Permeability** indicator aims to identify the main agricultural matrices in the Area of Influence of the Project Area and to assess their permeability for the groups of species considered in the Methodology.

For the composition of the indicator, the conditions and concepts necessary for its understanding must be considered, as set out in the following items.

5.2.3.3.1 FAUNAL GROUPS

To facilitate the delimitation of the influence of the land-use and land-cover matrix on the permeability of the species, this Methodology adopts a simplified classification of the faunal groups, considering their general ecological characteristics and their interaction with the landscape.

Medium- and large-sized vertebrate animals have been divided into three main groups, according to their ecological characteristics and the use of the landscape, as set out in the table below:

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[22] Available at: http://mtc-m21b.sid.inpe.br/col/sid.inpe.br/mtc-m21b/2014/10.22.19.05/doc/publicacao.pdf
[23] Available at: https://www.scielo.br/j/floram/a/rzj4C3Zzb3SNxbh9jtLNdSD/
[24] Available at: https://www.scielo.br/j/floram/a/rzj4C3Zzb3SNxbh9jtLNdSD/

Table 26. Faunal groups considered in the Methodology.

Faunal groups	
Non-flying arboreal	Animals that spend most of their time in the tree stratum, that is, on the trees, such as primates, sloths, arboreal marsupials and others, whose ecology depends directly on the presence of trees and of the forest canopy.
Terrestrial	Animals that carry out most of their biological activities in the terrestrial stratum, whether in forest or open environments, such as large felines, ungulates, rodents and others, whose ecology depends on the availability of habitat and of resources on the ground.
Flying	Animals with the ability to fly, which spend a large part of their time in the aerial stratum, such as birds, bats and others, whose ecology depends on the availability of aerial resources and on the connectivity of the landscape.

5.2.3.3.2 CLASSIFICATION OF LAND OCCUPATION AND USE

For the delimitation of the landscape structure, the classification from the MapBiomas platform must be used exclusively, which provides a standardized and regularly updated basis for the analysis of land use and land cover in the national territory.

First, natural ecosystems are considered, on account of their importance in landscape connectivity and in the provision of ecosystem services, as mentioned in item 5.2.3.1). As natural ecosystems, the following were considered: the Forests and Non-forest Natural Formation. Within the classification of Forests and Natural Formation, the various types of vegetation present in the Brazilian territory, such as dense, open, seasonal and mixed forests, as well as savanna and grassland formations, are included, as set out in Table 27.

For the identification of the land-use and land-cover matrices, the following uses considered on the MapBiomas platform were taken into account, as set out in Table 28. Use mosaics were not included in the Methodology, since it was not possible to distinguish that land use from the other matrices considered, which may result in uncertainties in the assessment of matrix permeability.

From the delimitation of the landscape structure, the Methodology ranks those with the greatest potential for providing ecosystem services, as set out in Table 29 and Table 30. Natural ecosystems present the highest score in the landscape context and are considered to be of high permeability for all the faunal groups considered in the Methodology.

The specifications of the natural ecosystems and of the different land-use and land-cover matrices considered in the Methodology are set out in the following tables, which present the scoring for the permeability of each matrix for the faunal groups considered:

Table 27. Natural ecosystems considered in the Matrix Permeability indicator.

Natural ecosystems considered	
Forests	Defined as natural ecosystems with forest structure composed predominantly of woody tree species, which form a continuous canopy and provide habitat for a wide diversity of fauna and flora (MapBiomas[25]).

[25] Available at: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/570911/cerrado-ecologia-e-flora

	Within the forest physiognomy, the following were included: Forest Formation, Mangrove, Flooded Forest, and other forest formations specific to Brazilian biomes.
Savannas and Grasslands	Defined as natural ecosystems that feature the tree component without the formation of a continuous canopy, with predominance of shrubs, herbs and grasses, providing habitat for specific species of fauna and flora adapted to open environments (MapBiomas[26]). Within Savannas and Grasslands, the following were considered: Savanna formation, Flooded grassland, Swamp area and other grassland formations specific to Brazilian biomes.

Table 28. Land-use and land-cover matrices considered in the Matrix Permeability indicator.

	Perennial Crop
Coffee, citrus and other crops	Perennial crops feature areas occupied by crops with a long vegetative cycle (more than one year), allowing for multiple harvests over the years and maintaining a relatively stable vegetation cover[27], thus influencing their structure. Examples of crops defined as perennial are: coffee, orange, cocoa, rubber, palm, coconut and other woody plants. The structure and resources available in the land-use and land-cover matrix are determinants for the permeability of species. In this sense, shrubs/trees, together with the presence of continuous vegetation cover, can facilitate the movement of species between the fragments of native vegetation and the matrix. For arboreal animals, when compared with the other groups (terrestrial and/or flying), perennial crops may provide refuge and food resources, especially in the presence of native vegetation in the surroundings of the cultivation areas. Animals typical of savannas and grasslands, considering both arboreal and terrestrial species, may use perennial crops as steppingstones in their movements between the fragments of native vegetation, contributing to the connectivity of the landscape. In conclusion, the three groups of species selected (arboreal, terrestrial and flying) present different responses to the presence of perennial crops in the landscape, and that diversity of responses must be considered in the assessment of the permeability of the matrix for the faunal groups.
	Annual Crop
Sugarcane and Soya	Annual crops are characterized as intensive agriculture, owing to their production system, which involves the annual cultivation of agricultural plants of short vegetative cycle, with intensive use of agricultural inputs and frequent land preparation. The agricultural practices associated with annual crops represent a condition of low functional value for the conservation of biodiversity, on account of the

[26] Available at: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/570911/cerrado-ecologia-e-flora

[27] Brazilian Institute of Geography and Statistics – IBGE. Technical Manual on Land Use, IBGE: Rio de Janeiro, Brazil, 1999, 58 pp.;
Brazilian Institute of Geography and Statistics – IBGE. Technical Manual on Brazilian Vegetation, 2nd ed., IBGE: Rio de Janeiro, Brazil, 2012. pp.157–160;
Food and Agriculture Organization of the United Nations – FAO. Manual for integrated field data collection. FAO: Rome, Italy, 2012, 175p.;
Ministry of Science, Technology and Innovation. Secretariat for Research and Scientific Training. Brazil's Fourth National Communication to the United Nations Framework Convention on Climate Change, Brasília, 2020, 620 pp.

	simplification of the landscape, the loss of native vegetation cover and the impact on the hydrological and nutrient cycles.[28 29]. Intensive agriculture management may negatively affect various groups of animals, through the loss of habitat, the reduction of food availability and the fragmentation of the landscape, compromising the connectivity of ecosystems and the maintenance of biodiversity.[30]. In summary, the three groups of species selected (arboreal, terrestrial and flying) present low functional value for permeability in annual crops, reflecting the negative impact of that activity on the conservation of biodiversity.
	Silviculture
Silviculture	Silviculture is associated with the cultivation of trees for commercial purposes and involves the planting of forest species of rapid growth, such as eucalyptus and pine, with the aim of producing wood, pulp and other forest products. Silviculture presents an environmental condition closer to areas with predominantly forest structure, provided that the management practices adopted favors biodiversity and the connectivity of the landscape. The greatest impact of silviculture relates to the periodicity of management of the crop. Short cutting cycles result in significant landscape disturbances, which may compromise the connectivity of ecosystems and the maintenance of biodiversity[31]. Accordingly, even with greater structural similarity, depending on the intensity of management, silviculture may present a condition of lower functional value for the conservation of biodiversity, affecting the permeability of the matrix for the faunal groups. Terrestrial animals, of forest or non-forest habits, are able to use the silviculture matrix as an area of movement, especially in situations where the management practices adopted favors the maintenance of native vegetation cover and the connectivity of the landscape. Terrestrial animals' characteristic of forest environments would be most benefited by the presence of silviculture, since it may provide refuge and food resources, especially in the presence of native vegetation in the surroundings of the cultivation areas.
	Pasture
Pasture	Pastures present a condition characteristic of open areas, without the presence of continuous canopy, with predominance of grasses and herbs, providing habitat for specific species of fauna and flora adapted to open environments. The absence of the canopy manifests a reduction in protection against predation and in thermal protection. The simplification of the landscape and the loss of native vegetation cover may compromise the connectivity of ecosystems and the maintenance of biodiversity. Terrestrial animals with open-area habits are the most likely to use pasture as an area of movement, especially in situations where the management

[28] Whittingham, M.J., Evans, K.L., 2004. The effects of habitat structure on predation risk of birds in agricultural landscapes. Ibis 146, 210–220.

[29] Brickle, N.W., Harper, D.G.C., Aebischer, N.J., Cockayne, S.H., 2000. Effects of agricultural intensification on the breeding success of corn buntings Miliaria calandra. J. Appl. Ecol. 37 (5), 742–755.

[30] Goulart et al. How do different agricultural management strategies affect bird communities inhabiting a savanna-forest mosaic? A qualitative reasoning approach. Agriculture, Ecosystems & Environment, v. 164, p. 114–130, 1 jan. 2013.

[31] Putz, F. E., Sirot, L. K., & Pinard, M. A. (2001). Tropical forest management and wildlife: Silvicultural Effects on Forest Structure, Fruit Production, and Locomotion of Arboreal Animals. In R. A. Fimbel, A. Grajal, & J. G. Robinson (Eds.), The Cutting Edge: Conserving Wildlife in Logged Tropical Forests (pp. 11–34). Columbia University Press. http://www.jstor.org/stable/10.7312/fimb11454.8.

	practices adopted favor the maintenance of native vegetation cover and the connectivity of the landscape.
	Non-vegetated area[32]
Beach, dune and sandy location	Sandy areas, bright white in color, where there is no predominance of vegetation of any kind.
Urban area	Urban areas with a predominance of non-vegetated urban surfaces, including roads, buildings and other urban structures, which may compromise the connectivity of ecosystems and the maintenance of biodiversity.
Mining	Areas with clear evidence of extensive mineral extraction present evident soil exposure, with alteration of the landscape structure and loss of native vegetation cover, compromising the connectivity of ecosystems and the maintenance of biodiversity.

5.2.3.3.3OBTAINING THE MATRIX PERMEABILITY INDICATOR

To obtain the **Matrix Permeability Indicator** the Methodology requires:

i. Relating the Matrix Permeability indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Project Area and the buffer area of the Area of Influence. In this case, the rural properties selected for the Project Area are not taken into account, see item 5.13.
iii. Carry out the classification of land use and land occupation considering MapBiomas in the analysis area;
iv. Consider the class “Natural ecosystems” and allocate the different types of vegetation in accordance with the classification of Forests and Non-forest Natural Formation, as set out in Table 27;
v. Consider the land-use and land-cover matrix classifications: Pasture; Temporary crop; Perennial crop; Silviculture; Non-vegetated area; and Mining, as set out in Table 28;
vi. Complete the column “Extent of areas according to land use” in Table 29 and Table 30, in accordance with the MapBiomas classification;
vii. Multiply the extent of area according to land use by the ranking of permeability of the matrix for the faunal groups considered;
viii. Perform the final summation and obtain the Matrix Permeability Indicator.

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner

[32] Available at https://brasil.mapbiomas.org/wp-content/uploads/sites/4/2023/09/ATBD-Collection-8-v1.1.docx.pdf

Table 29. Matrix permeability for natural forest ecosystems.

Matrix Permeability – Forest						
			Faunal groups			Score
Indicator	Extent of areas according to land use (%)	Type of Cultivation	arboreal	terrestrial	flying	Sum of the scoring of the habits x percentage proportion of land use (%)
Matrix permeability	%	Natural ecosystems	10	10	10	30 x $Prop_{EcoNat}$%
	%	Perennial crop	3	5	5	13 x $Prop_{PerCrop}$%
	%	Annual crop	1	2	1	4 x $Prop_{AnnCrop}$%
	%	Silviculture	4	5	5	14 x $Prop_{Silvic}$%
	%	Pasture	1	2	2	6 x $Prop_{Pasture}$%
	%	Non-vegetated area	0	0	0	0 x $Prop_{NonVeg}$%
Total = Sum of the scores by type of land use						**Final Sum**

Table 30. Matrix permeability for savanna and grassland environments.

Matrix Permeability – Savannas and grasslands						
			Faunal groups			Score
Indicator	Extent of areas according to land use (%)	Type of Cultivation	arboreal	terrestrial	flying	Sum of the scoring of the habits x percentage of land use
Matrix permeability	%	Natural ecosystems	10	10	10	30 x $Prop_{EcoNat}$%
	%	Perennial crop	3	4	5	12 x $Prop_{PerCrop}$%
	%	Annual crop	1	2	1	4 x $Prop_{AnnCrop}$%
	%	Silviculture	3	3	4	10 x $Prop_{Silvic}$%
	%	Pasture	1	4	2	7 x $Prop_{Pasture}$%
	%	Non-vegetated area	0	0	0	0 x $Prop_{NonVeg}$%
Total = Sum of the scores by type of land use						**Final Sum**

5.2.4 APP CONSERVATION (MANDATORY)

APPs are good sources of EcS, since they provide significant support for the provision of water, the maintenance of biodiversity and the conservation of ecosystems. The conservation of APPs is a mandatory Ecosystem Indicator of this Methodology, in view of the importance of those areas for the provision of ecosystem services and the conservation of biodiversity.

Diagnosis may be carried out by means of the analysis of native vegetation cover in the APPs, which allows the state of conservation of those areas and their contribution to the provision of ecosystem services to be assessed.

To obtain the **APP Conservation Indicator**:

i. Relate the APP Conservation indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Area of Influence, considering the buffer and the rural properties of the Project Area, see item 5.13.
iii. The mapping of the Permanent Preservation Areas (APPs) may be carried out based on official data bases, such as the Rural Environmental Registry (CAR), or based on cartographic bases of recognized quality, ensuring the accuracy and reliability of the information used in the analysis.
iv. Obtain the classes of wooded and/or forested vegetation, or other types of native vegetation, which are representative of the region, from secondary data bases of recognized quality.
v. By means of GIS tools, intersect the APP base(s) with the TNVA to determine the area of native vegetation in the APP, thus obtaining the percentage of native vegetation cover in the APP in relation to the total area of the APP.
vi. Obtain the percentage of cover with native vegetation in APP (%), calculated as the native vegetation in the APP divided by the total area of the APP.
vii. Assign scoring in accordance with the table below.
viii. Provide characterization and ecological value determining the importance of the indicator in the scenario of the project, on the basis of the percentage of native vegetation cover in APP.

Table 31. Scoring for the APP conservation indicator.

Indicator	Description	Score
Percentage of native	CAPP ≤ 70%	1
vegetation in APP area (CAPP)	70% < CAPP ≤ 80%	3
Effective APP	80% < CAPP ≤ 90%	4
Mandatory APP	90% < CAPP ≤ 100%	5

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.2.5 SPRING DENSITY

The quantity of springs in a given area is directly related to the state of conservation of aquatic and terrestrial ecosystems, the quality of water and the availability of water resources. Spring density is an optional Ecosystem Indicator of this Methodology, which allows the state of conservation of ecosystems and their contribution to the provision of ecosystem services related to water resources to be assessed.

For the calculation of the **Spring Density Indicator**, the following steps must be taken:

i. Relate the Spring Density indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;

ii. The analysis area of the indicator is the Area of Influence, considering the buffer and the rural properties of the Project Area, see item 5.13.
iii. By means of GIS tools, account for the springs within the Project Area and compare with the springs of the Area of Influence, using cartographic bases of recognised quality, such as those of the Brazilian Sustainable Development Foundation (FBDS).
iv. The FBDS (Brazilian Sustainable Development Foundation) database must be used as a reference for the mapping of springs, ensuring the accuracy and reliability of the information used in the analysis.
v. List all the properties (Area of Influence and Project Area together) from the highest to the lowest spring density, based on the total number of properties considered in the analysis of the indicator. *T* (where *T* is the total number of properties considered in the analysis of the indicator).
vi. Count the total of properties with zero density (*N*), that is, those that do not have any spring on their property.
vii. Subtract *N* (total of properties with density equal to zero) from *T* (total number of properties), arriving at the total number of properties that contain one or more springs on their property (*D*):

Equation 14. Total of properties with non-zero spring density.

$$D = T - N$$

viii. Classify the properties by decreasing spring density, as per the following step;

a. Divide the total number of properties with non-zero density (*D*) by 4, arriving at the value *m* (classification interval):

Equation 15. Determination of the classification interval.

$$m = \frac{D}{4}$$

b. Round *m* to the nearest whole number;
c. Starting from the property with the highest spring density (property defined as 1, in accordance with the ordering of step v), classify the first *m* with a score of 5. Classify the next *m* with a score of 4, the following *m* with a score of 3, and the last *m* properties with non-zero density with a score of 2. In this way, the *D* properties with non-zero density will present scores ranging from 5 to 2, with the property *D*, which presents the lowest non-zero density, being scored 2;
d. Consider all those with zero density (*Z*) with a score of 1;
e. Generate a table with that information, necessarily including the columns:
    - CAR number;
    - Location of the property (Project Area or Area of Influence);
    - Density (springs/ha);
    - Ranking, in accordance with item v, ranging from 1 (property of highest density) to *T* (property of lowest density);
    - Score, ranging from 5 to 1, with the score of 1 being assigned only to properties with zero density (*Z* properties with a score of 1).

ix. Compare the frequency of densities of the properties in the Area of Influence with those of the Project Area;
x. Score the Project Area in accordance with the table below.
xi. Assign ecological value and characterization relating to the importance of that indicator in the ecosystem, on the basis of the spring density of the Project Area in comparison with the Area of Influence.

Table 32. Scoring for the spring density indicator.

Indicator	Spring density of Project Area and Area of Influence	Score
Spring density (SD) of Project Area and Area of Influence	SD = 0	1
	Low	2
	Medium	3
	High	4
	Very High	5

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios.
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.2.6 BIODIVERSITY (MANDATORY)

In general, the term biodiversity refers to biological diversity, that is, the set of all living species, their interactions with each other and with the environment, and the ecosystem processes that sustain life on Earth[33].

Biodiversity influences the provision of EcS in its various classifications: (i) as support for ecosystem processes, (ii) as provisioning of environmental goods and products, (iii) as regulation of ecosystem processes, and (iv) as a cultural component, providing non-material benefits to society[34 35 36].

Biodiversity indicators have great utility when they are clear in their definitions and measurements, allowing the state of conservation of ecosystems and their ability to provide ecosystem services to be assessed[37]. Biodiversity indicators must summarize data on complex environmental issues, allowing the state of conservation of ecosystems and their ability to provide ecosystem services to be assessed in an integrated and comparable manner.

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[33] WWF Brazil, Available at:: https://www.wwf.org.br/natureza_brasileira/questoes_ambientais/biodiversidade/#:~:text=O%20termo%20biodiversidade%20%2D%20ou%20diversidade,industrial%20consumida%20pelo%20ser%20humano.

[34] Mace et al., 2012. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0169534711002424

[35] Constanza et al., 2017. Available at: https://www.sciencedirect.com/science/article/abs/pii/S2212041617304060

[36] Borma et al., 2022. See at: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021RG000766

[37] Carvalho 2019. Available at: https://pantheon.ufrj.br/bitstream/11422/13622/1/LucasSilvaCarvalho-min.pdf

Accordingly, the Methodology establishes Biodiversity indicators for Flora and Fauna, considering direct and indirect indications about fauna and flora, as well as disturbance factors that may compromise the provision of ecosystem services and the maintenance of biodiversity.

In order to assign value to the indicators, the Methodology provides for the verification of the quality of the Ecosystem Indicators through monitoring in situ carried out by the figure of the Monitoring Agent, see item 6.1.1. The scoring will be assessed by the developer's team, where the higher the value obtained, the greater the contribution of the indicator to the conservation of biodiversity and the provision of ecosystem services.

5.2.6.1 BIODIVERSITY – FLORA

The achievement of balance in forest environments involves the process of ecological succession, which allows for the recovery of native vegetation and the maintenance of biodiversity[38]. The progression of succession entails changes in the dynamics of the vegetation, with the diversification of plant species and the structuring of ecosystems, favoring the provision of ecosystem services and the conservation of biodiversity.

In this sense, the identification of successional stages of a forest and its disturbance factors is fundamental for the assessment of the quality of the habitat and of the connectivity of the landscape, allowing the state of conservation of ecosystems and their ability to provide ecosystem services to be assessed[39].

To obtain the **Biodiversity Indicator – Flora (I_{BFL})** the Methodology requires:

i. Relate the Biodiversity indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Project Area, see item 5.13.
iii. Use data obtained in accordance with the guidance set out further on, in item 5.13.1.4. The lists of flora species and the cartographic products resulting from the characterization of fauna and flora (see item 5.13.1.4) must be used as the basis for the composition of the Biodiversity Indicator – Flora of the Project Area.
iv. The tables below set out the sub-indicators selected to act as indirect indicators of Biodiversity – Flora, with the corresponding scoring and the criteria for their application:
v. Provide information to characterize the relevance of this indicator for the ecosystem in which the Project Area is located, highlighting the importance of the disturbance factors and of the structural characteristics of the vegetation for the conservation of biodiversity.

The flora sub-indicators were created through adaptations of classifications of successional stages and disturbance factors, allowing the state of conservation of the vegetation and the ability of the ecosystem to provide ecosystem services to be assessed.

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38 Townsend et al., Fundamentals of Ecology. 3rd ed. Brazil: Artmed, 2010. 557 pp..

39 Longhi et al., 2005. Available at: https://www.scielo.br/j/cflo/a/qp7J4kPjq7m3rFSxZWsXKYP/

It is recommended that:

- The recording of the interior of the fragment with the presence of objects, such as a colored ribbon, to ensure the identification of the location and the verification of the indicators, as well as the registration of photographs with date and geographical coordinates, to guarantee the traceability of the information.
- The evidence of successional stages must be recorded in situ by means of photographic records containing date and geographical coordinates, to ensure the traceability of the information and the verification of the indicators.

Table 33. Scoring for the Biodiversity Indicator (Forest formations) – Flora.

Indicator	Vegetation structure	Level	Score
Biodiversity – Vegetation	Physiognomy	Physiognomy ranging from savanna to low forest, possibly with herbaceous stratum and small trees, characteristic of ecosystems in initial stage of ecological succession.	1
		Forest physiognomy, presenting trees of various sizes.	3
		Closed forest physiognomy, tending to present continuous canopy distribution, with the canopy possibly forming two or more strata, characteristic of ecosystems in advanced stage of ecological succession.	5
	Forest stratification	Woody strata ranging from open to closed, with plants of varying heights, characteristic of ecosystems in initial stage of ecological succession.	1
		Presence of plant species of different heights, forming the beginning of the formation of diversified strata, characteristic of ecosystems in intermediate stage of ecological succession.	3
		Well-defined forest stratification, with trees, shrubs, terrestrial herbs, vines, epiphytes and other characteristic plants of advanced ecosystems, characteristic of ecosystems in advanced stage of ecological succession.	5
	Diametric distribution of tree individuals	Mean diameter of the trunks at breast height (DBH = 1.30 m from the ground) is up to 10 cm, presenting a narrow diametric distribution, characteristic of ecosystems in initial stage of ecological succession.	1
		Mean DBH may reach up to 20 cm. The diametric distribution of the trees presents medium amplitude, characteristic of ecosystems in intermediate stage of ecological succession.	3
		Mean DBH of the trunks is always greater than 20 cm. The diametric distribution has a large amplitude, characteristic of ecosystems in advanced stage of ecological succession.	5
	Presence of epiphytes	Epiphytes, where present, are not abundant.	1
		Epiphytes appear in a greater number of individuals and species (e.g. lichens, mosses, orchids and bromeliads), characteristic of ecosystems in intermediate stage of ecological succession.	3
		Epiphytes are present in a large number of species and in great abundance.	5

Indicator	Vegetation structure	Level	Score
	Presence of litter	The litter, where present, may be continuous or not, forming a thin and little-decomposed layer, characteristic of ecosystems in initial stage of ecological succession.	1
		The litter may present variations in thickness, according to the season. Between the seasons, the litter may be continuous or not, forming a layer of medium thickness, characteristic of ecosystems in intermediate stage of ecological succession.	3
		The litter is present, varying as a function of time and location, is easily detectable and forms a thick and well-decomposed layer, characteristic of ecosystems in advanced stage of ecological succession.	5
	Plant Diversity	Biological diversity is low, with around ten tree or shrub species possibly occurring, characteristic of ecosystems in initial stage of ecological succession.	1
		Biological diversity is significant, with the dominance of a few species potentially occurring in some cases, characteristic of ecosystems in intermediate stage of ecological succession.	3
		Biological diversity is very high owing to the structural complexity and the number of species.	5

Table 34. Scoring for the Biodiversity Indicator (Savanna formations) – Flora.

Indicator	Vegetation structure	Level	Score
Biodiversity – Vegetation	Physiognomy	Forest formations with predominance of tree species, with continuous canopy formation, characteristic of ecosystems in initial stage of ecological succession.	1
		Savanna physiognomy: characterized by the presence of trees in large quantities, still without the formation of a continuous canopy, characteristic of ecosystems in intermediate stage of ecological succession. Grassland physiognomy: presence of trees and shrubs, of exotic grasses and ruderal herbs, characteristic of ecosystems in intermediate stage of ecological succession.	3
		Savanna physiognomy: characterized by the presence of arboreal and sub-shrub/herbaceous strata, characteristic of ecosystems in advanced stage of ecological succession. Grassland physiognomy: absence of trees, presence of scattered sub-shrubs and predominance of native grasses and herbs, characteristic of ecosystems in advanced stage of ecological succession.	5
	Forest stratification	Well-defined forest stratification, with trees, shrubs, terrestrial herbs, vines, epiphytes and other characteristic plants of advanced ecosystems, characteristic of ecosystems in advanced stage of ecological succession.	1

Indicator	Vegetation structure	Level	Score
		Savanna physiognomy: predominance of the arboreal stratum over the sub-shrub and herbaceous, characteristic of ecosystems in intermediate stage of ecological succession. Grassland physiognomy: presence of only one well-defined stratum, the grassland one, with soil cover by native vegetation, characteristic of ecosystems in intermediate stage of ecological succession.	3
		Savanna physiognomy: presence of two well-defined strata composed of the arboreal and sub-shrub/herbaceous strata, characteristic of ecosystems in advanced stage of ecological succession. Grassland physiognomy: presence of only one well-defined stratum, the grassland one, with soil cover by native vegetation, characteristic of ecosystems in advanced stage of ecological succession.	5
	Presence of litter	The litter is present, varying as a function of time and location, is easily detectable and forms a thick and well-decomposed layer, characteristic of ecosystems in advanced stage of ecological succession.	1
		The litter may present variations in thickness, according to the season. Between the seasons, the litter may be continuous or not, forming a layer of medium thickness, characteristic of ecosystems in intermediate stage of ecological succession.	3
		The litter, where present, may be continuous or not, forming a thin and little-decomposed layer, characteristic of ecosystems in initial stage of ecological succession.	5
	Plant Diversity	Savanna physiognomy: biological diversity is low, with around ten tree or shrub species possibly occurring, characteristic of ecosystems in initial stage of ecological succession. Grassland physiognomy: soil cover by native vegetation up to 20% or vegetation visibly degraded, characteristic of ecosystems in initial stage of ecological succession.	1
		Savanna physiognomy: biological diversity is low, with the dominance of some plants potentially occurring, characteristic of ecosystems in intermediate stage of ecological succession. Grassland physiognomy: soil cover by native vegetation up to 50%	3
		Biological diversity is very high owing to the structuring of the different life forms, characteristic of ecosystems in advanced stage of ecological succession.	5

Table 35. Scoring for the Biodiversity Indicator (Forest level) – Disturbance factors.

Indicator	Disturbance factors	Level	Score
Biodiversity –		High – every 1 to 2 years Medium – every 3 to 5 years	1 3

Indicator	Disturbance factors	Level	Score
Disturbance factors	Frequency of Fire in the area	Low – every 5 to 10 years	5
	Presence of cattle or any domesticated animal inside the native vegetation fragment	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5
	Presence of vines	Vines, which may be herbaceous or woody, in high abundance, covering, in almost all of their extent, the trees at the edge of the fragment and in its interior.	1
		Vines, which may be herbaceous or woody, in moderate abundance, partially covering the trees at the edge of the fragment and in its interior.	3
		Absence of vines covering the trees at the edge of the fragment; in the interior, where present, they do not cover the trees or cover them to a small extent.	5
	Presence of invasive grasses	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5
	Presence of exotic trees	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5
	Presence of selective timber cutting in the area	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5

Table 36. Scoring for the Biodiversity Indicator (Savanna level) – Disturbance factors.

Indicator	Disturbance factors	Level	Score
Biodiversity – Disturbance factors	Frequency of Fire in the area	Poor – every 5 to 10 years	1
		Medium – every 3 to 5 years	3
		Good – every 2 years	5
	Presence of cattle or any domesticated animal inside the native vegetation fragment	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5

Indicator	Disturbance factors	Level	Score
	Presence of vines	Vines, which may be herbaceous or woody, in high abundance, covering, in almost all of their extent, the trees at the edge of the fragment and in its interior.	1
		Vines, which may be herbaceous or woody, in moderate abundance, partially covering the trees at the edge of the fragment and in its interior.	3
		Absence of vines covering the trees at the edge of the fragment; in the interior, where present, they do not cover the trees or cover them to a small extent.	5
	Presence of invasive grasses	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5
	Presence of exotic trees	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5
	Presence of selective timber cutting in the area	High – 51 to 100%	1
		Medium – 21 to 50%	3
		Low – 0 to 20%	5

The sub-indicators must have their scoring highlighted in the table and must be summed to determine the final score of the Biodiversity Indicator – Flora, in accordance with the equation below:

Equation 16. Final score of the Biodiversity Indicator – Flora

$$I_{BFl} = \sum Pt_{subindicators}$$

Where:

Table 37. Parameters for obtaining the final score of the Biodiversity Indicator – Flora.

I_{BFl}	=	Final score obtained for the Biodiversity Indicator – Flora
$Pt_{subindicators}$	=	Partial scores for each sub-indicator of Vegetation Structure and Disturbance Factors

The Biodiversity – Flora Indicator has a weight of 2 in the Ecosystem Indicators Matrix (see item 5.5), since it encompasses flora and disturbances.

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios (see item 5.13.1.4);
- Images and supporting accounts must be included in the relevant Reports;
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.
- For the disturbance factors identified, the EnS provider must supply the developer with supporting evidence of the occurrence of those factors, such as images, accounts, documents and other information that allow the verification of the indicators and the traceability of the information.

5.2.6.2 BIODIVERSITY – FAUNA

As regards fauna, diversity may be directly measured in a given location through the identification of species, abundance and richness of species, allowing the state of conservation of ecosystems and their ability to provide ecosystem services to be assessed. However, direct measurement of faunal diversity is often limited by the availability of data and by the difficulty of identifying species in the field.

Furthermore, the trophic chain plays a fundamental role in the maintenance of a healthy ecosystem, with top-of-chain species, such as large predators, being crucial for the regulation of populations of prey species and for the maintenance of ecological balance[40], among others that clearly demonstrate their significance in maintaining the ecological balance and the provision of ecosystem services.

Moreover, a well-developed ecosystem supports the richness and abundance of pollinators, among other key faunal groups for the maintenance of biodiversity and the

[40] Available at:: https://www.iucnredlist.org/

provision of ecosystem services[41], whose diversity is associated with floristic diversity[42] and with the variety and complexity of forest strata[43,44]. Pollination is an important EcS, fundamental for the reproduction of many plants, including agricultural crops, and the presence of pollinators is an indirect indicator of the health of the ecosystem and of the provision of ecosystem services.

To obtain the **Biodiversity Indicator – Fauna** the Methodology requires:

i. Relate the Biodiversity indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Project Area, see item 5.13.
iii. Use data obtained in accordance with the guidance set out further on, in item 5.13.1.4. The lists of fauna and flora species and the cartographic products resulting from the characterization of fauna and flora (see item 5.13.1.4) must be used as the basis for the composition of the Biodiversity Indicator of the Project Area.
iv. The tables below set out the sub-indicators selected to act as indirect indicators of Biodiversity – Fauna, with the corresponding scoring and the criteria for their application:
v. Provide information to characterize the relevance of this indicator for the ecosystem in which the Project Area is located, highlighting the importance of the faunal groups and of the ecological characteristics of the species for the conservation of biodiversity.

The fauna indicators consider ecological aspects relevant to the health of the ecosystem, such as the presence of key species, top-of-chain species, threatened species and evidence of well-established populations, allowing the state of conservation of biodiversity and the ability of the ecosystem to provide ecosystem services to be assessed.

- The recording of the interior of the fragment with the presence of objects, such as a colored ribbon, to ensure the identification of the location and the verification of the indicators, as well as the registration of photographs with date and geographical coordinates, to guarantee the traceability of the information.
- The evidence of well-established populations must be recorded in situ by means of photographic records containing date and geographical coordinates, so as to ensure the traceability of the information and the verification of the indicators.
- Photographic records of fauna sightings in the area, evidence such as footprints, nests of birds or other wildlife, and other indications of the presence of species in the area, must be included in the relevant Reports.

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[41] McGregor EcS. 1976. Insect pollination of cultivated crop plants. Washington, DC: Agriculture Research Service United States, Department of Agriculture

[42] Ramalho, 2009. Available at: https://www.scielo.br/j/rbent/a/69zG6FVpVtjcLVq8TDvYGgf/abstract/?lang=pt

[43] Martins, 2015. Available at: https://www.scielo.br/j/rbzool/a/tV97ZfKtDWsC4hqfwK8BTxz/?lang=pt

[44] Viana, 2006. Available at: http://periodicos.uefs.br/index.php/sitientibusBiologia/article/download/8194/6800/32701

Table 38. Scoring for the Biodiversity Indicator – Fauna.

Indicator	Fauna	Level	Score
Biodiversity – Fauna	Records of key species / top of chain	No records	1
		1 or more records	5
	Presence of species threatened with extinction on a global and national scale	Vulnerable	1
		Threatened	3
		Critically endangered	5
	Evidence of well-established populations	1 to 3 species	1
		3 to 5 species	3
		5 or more species	5

The indicators must have their scoring highlighted in the table and must be summed to determine the final score of the Biodiversity Indicator – Fauna, I_{BFN}, in accordance with the equation below. In the case of the indicator of presence of threatened species, the highest score obtained must be considered, as set out in the table above.

Equation 17. Final score of the Biodiversity Indicator – Fauna

$$I_{BFN} = \sum Pt_{subindicators}$$

Where:

Table 39. Parameters for the final score of the Biodiversity Indicator – Fauna.

I_{BFN}	=	Final score obtained for the Biodiversity Indicator – Fauna
$Pt_{subindicators}$	=	Partial scores for each sub-indicator of fauna biodiversity

It is emphasised that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios (see item 5.13.1.4);
- Images and supporting accounts must be included in the relevant Reports;
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.2.7 SOCIOCULTURAL IMPACT (MANDATORY)

Cultural ecosystem services (see item 5.1.1) go beyond the mere utility of nature and encompass the sphere of immaterial experiences, such as recreation, tourism, cultural identity, spiritual and aesthetic experiences and intellectual development, which contribute to the well-being of society and the conservation of ecosystems.

In general, all elements of the structural or functional landscape contribute to the provision of cultural ecosystem services, and the Sociocultural Impact indicator is a mandatory Ecosystem Indicator of this Methodology, aimed at assessing the contribution of the Project Area to the provision of cultural ecosystem services and the well-being of society, as set out in item 5.4.

To obtain the **Sociocultural Impact Indicator** the Methodology requires:

i. Relate the Sociocultural indicator to the corresponding EcS indicated in item 5.1.2. Present in table format and describe which of the listed EcS may be measured with the indicator;
ii. The analysis area of the indicator is the Project Area, see item 5.13.
iii. Use data obtained from public bases and the lists of identified locations.
iv. Any cartographic products must be used as the basis for the composition of the Sociocultural Impact Indicator of the Project Area, highlighting the importance of the cultural elements and the characteristics of the landscape for the provision of cultural ecosystem services.
v. Consider the sub-indicators selected to act as indirect indicators of Cultural EcS, in accordance with the table below:
vi. The scoring will be assessed by the developer's team, where the higher the value obtained, the greater the contribution of the indicator to the provision of cultural ecosystem services and the well-being of society.

The sub-indicators were created through the identification of urban facilities or cultural attractions that may contribute to the provision of cultural ecosystem services, such as museums, parks, monuments, religious sites and other cultural elements.

It is recommended that:

- the identified indicators be evidenced and recorded in situ by means of photographic records containing date and geographical coordinates, so as to ensure the traceability of the information and the verification of the indicators.

Table 40. Scoring for the Sociocultural Impact Indicator.

Theme	Indicator	Description	Score	
Landscape valuation	Number of visitors	Number of people who annually visit the area for activities such as rural tourism, wildlife observation, hiking and other cultural and recreational activities.	<10 10-30 30-60 60-90 >90	1 2 3 4 5
Recreation and leisure	Number of leisure areas	Number of green areas, parks and other spaces intended for recreation located within the Project Area or in its immediate surroundings.	<1 1-3 3-6 6-9 >9	1 2 3 4 5
	Diversity of leisure activities	Number of different leisure activities, such as hiking, cycling, picnics, bird watching and other recreational activities, available in the Project Area.	<3 3-5 >5	1 3 5
Education and knowledge	Number of teaching programs or tools	Quantifies the teaching programs or tools that make use of the Project Area (whether funded or not), such as environmental education, scientific research and other educational activities.	<1 1-3 3-6 6-9 >9	1 2 3 4 5
	Number of participants in	Quantifies the number of people who annually take part in programs under the item above.	<10 10-30 30-60	1 2 3

Theme	Indicator	Description	Score	
	educational programs		60-90	4
			>90	5
Cultural inspiration	Number of cultural events	Quantifies the cultural events that are held in the Project Area (whether funded or not by the Project), such as festivals, exhibitions, workshops and other cultural activities.	<3	1
			3	2
			4	3
			5	4
			>5	5

The indicators must have their scoring highlighted in the table and must be summed to determine the final score of the Sociocultural Impact Indicator, in accordance with the equation below:

It is emphasized that:

- Where pertinent, cartographic products must be presented;
- Images and supporting accounts must be included in the relevant reports;
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.3 AGRICULTURAL PRACTICES INDICATORS

The Agricultural Practices Indicator is the factor used by this Methodology to characterize and attribute value to the good agricultural practices adopted in the Project Area. The Agricultural Practices Indicators may be mandatory or optional, as shown in the table below. In the case of the mandatory Agricultural Practices Indicators, all must be analyzed for the composition of the Agricultural Practices Indicators Matrix; as for the optional ones, the developer may select the indicators that are most applicable to the project's context, considering the available data and the feasibility of carrying them out.

In the items that follow, the indicators relating to the use of an area with an association of good agricultural practices, such as the use of agrochemicals, water resources, sustainable soil management and sustainable fertilizer management, are described. Those indicators are relevant for the assessment of the sustainability of agricultural practices and of the provision of ecosystem services in the Project Area.

In the event that it proves impossible to complete any of the required Agricultural Practices Indicators, it is necessary to provide justification. Importantly, in the event of justified impossibility, the indicator will receive a score of zero in the calculation of the Agricultural Practices Indicators Matrix.

It is emphasized that the development of the PSA project must necessarily take into account at least 5 Agricultural Practices Indicators listed in this item, with four being mandatory and at least one being optional, chosen by the developer.

Table 41. Agricultural Practices Indicators.

Theme	Agricultural Practices Indicator	Requirement
Agrochemicals	Agrochemicals – Scenario 1 Agrochemicals – Scenario 2 Agrochemicals – Scenario 3	One of the indicators is mandatory
Water resources	Impact of Arable Areas on Water Quality (IAAWQ)	Optional
	Water Sustainability in Agriculture (WSA)	Optional
	Water Use Efficiency	Mandatory
	Water infiltration and run-off	Optional
Soil	Sustainable Soil Management	Mandatory
Fertilisers	Efficient Fertiliser Application	Mandatory

It is emphasized that, when preparing the MCR (see item 7.1), the Agricultural Practices Indicators selected by the developer must be listed and justification provided for that choice, which must also be presented when preparing the Monitoring Reports (MR) and the Methodology Compliance Report and Monitoring Report (CRMR) set out in items 7.2 and 7.3.

5.3.1 AGROCHEMICALS

By assessing the good agricultural practices applied in a given Project Area, the Methodology addresses the use of agrochemicals and their impact on the environment and on human health. The use of agrochemicals is a relevant aspect of agricultural practices, in so far as it affects the quality of the soil, water and biodiversity, as well as the health of workers and of the surrounding communities.

The term Agrochemical has the same meaning as agricultural pesticide, agrotoxic, pesticide, pest-control product and other equivalent terms used in the literature and in national and international regulation[45].

A range of other definitions may also be found in the literature on the subject:

i. Agricultural pesticides, agrochemicals, pesticides or pest-control products are natural or synthetic products used to prevent, control or eliminate pests, diseases and weeds affecting agricultural crops[44,46].
ii. Agricultural pesticides are substances with biological action whose purpose is to protect plants against pests and diseases, ensuring agricultural production and the quality of the crops[44,47].
iii. Agricultural pesticides, pest-control products or pesticides are chemical substances used to prevent, control or eliminate pests, diseases and weeds affecting agricultural crops[44,48].

[45] BNDES Setorial, Rio de Janeiro, no. 24, pp. 69–96, Sept. 2006. Available at: https://web.bndes.gov.br/bib/jspui/handle/1408/1304?mode=full. Accessed on: 11 March 2024.
[46] Martinelli, O. Final Sector Report – Agrochemical Sector. Finep, Nov. 2005.
[47] Azevedo, F. R., Freire, F. C. O. Technology for the application of pesticides / - Fortaleza: Embrapa Agroindústria Tropical, 2006. Available at: https://www.infoteca.cnptia.embrapa.br/bitstream/doc/426350/1/Dc102.pdf. Accessed on 11 March 2024.
[48] Gonçalves, F. M. Agrochemicals: monitoring the health of exposed workers. Course at the “ANAMT Congress”. Goiânia, May 2004.

Toxicology is the field of knowledge dedicated to understanding the limits of exposure and of risk to human health and the environment and is fundamental for the assessment of the use of agrochemicals and for the determination of the good practices of application.

According to the National Cancer Institute (INCA) of the Brazilian Federal Government, agrochemicals are chemical substances used to prevent, control or eliminate pests, diseases and weeds affecting agricultural crops. However, the use of agrochemicals may pose risks to human health and to the environment, particularly when used inappropriately or excessively.

According to Friedrich (2022), in 2015 the INCA released the ABRASCO Dossier, a document which sets out the risks of the use of agrochemicals to human health and to the environment, and which has been widely used as a reference in Brazilian scientific and regulatory literature.

The Brazilian Health Regulatory Agency (Anvisa) is the body responsible for coordinating the actions of registration, reassessment and control of agrochemicals in Brazil, on the basis of the relevant legislation and of the technical and scientific guidelines of the Ministry of Health.

In 2019, Anvisa promulgated the toxicological reclassification of agrochemicals already registered in Brazil, based on the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), which established new categories of classification based on acute toxicity and on other criteria relevant to human health and to the environment.

The reclassification process was necessary because, with the new regulatory framework of the sector, Brazil adopted the international GHS criteria, which allowed a more accurate and standardized classification of the risks associated with agrochemicals, in line with international best practice.

It is worth noting that the GHS expanded the toxicological classification categories from four to five, including a category for products unlikely to cause acute harm, which allows a more accurate and proportionate classification of the risks associated with agrochemicals.

The process of toxicological reclassification of agrochemicals began in 2017, when Anvisa published the technical directive for the reclassification and carried out public consultations with the sector and with civil society, culminating in the publication of the final reclassification in 2019.[49].

Accordingly, in accordance with the Ministry of Health (MS) and Anvisa, on 29 July 2019 the Resolution of the Collegiate Board of Anvisa (RDC) No. 294/2019 was published, which establishes the criteria and procedures for the toxicological classification of agrochemicals in Brazil, in line with the international GHS criteria.[50].

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[49] Toxicological reclassification of agrochemicals published. ANVISA. Available at: https://www.gov.br/anvisa/pt-br/assuntos/noticias-anvisa/2019/publicada-reclassificacao-toxicologica-de-agrotoxicos. Accessed on: 26 February 2024.

[50] Resolution of the Board of Directors – RDC No. 294, dated 29 July 2019. Available at: https://antigo.anvisa.gov.br/documents/10181/2858730/RDC_294_2019_.pdf/c5e8ab56-c13d-4330-a7a4-153bed4c5cda. Accessed on 8 February 2024.

CHAPTER IV ON TOXICOLOGICAL CLASSIFICATION

Section I – On the classification categories

Article 37. For the purposes of toxicological classification, criteria based on the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) are adopted, as set out in this Resolution and in the technical rules of Anvisa.

Sole paragraph. Updates to the criteria and general guidelines on classification and labelling of agrochemicals shall be carried out by Anvisa in accordance with the technical and scientific guidelines of the Ministry of Health and with international best practice.

Article 38. With regard to acute oral toxicity (oral LD50), dermal (dermal LD50) and inhalation (inhalation LC50), agrochemicals shall be classified into five categories, as set out in the table below, in accordance with the international GHS criteria.

§1 The toxicological classification of agrotoxics, related products and wood preservatives in one of the five categories shall be carried out in accordance with the criteria set out in the technical rules of Anvisa and in line with the international GHS criteria.

Article 39. The classification as a function of the acute toxicity of agrotoxics, related products and wood preservatives shall be carried out in accordance with the categories set out below:

I – Category 1: Extremely Toxic Product – red band;
II – Category 2: Highly Toxic Product – red band;
III – Category 3: Moderately Toxic Product – yellow band;
IV – Category 4: Slightly Toxic Product – blue band;
V – Category 5: Product Unlikely to Cause Acute Harm – blue band; and
VI – Not Classified – Non-Classified Product – green band.

RESOLUTION-RE No. 2,080 OF 31 JULY 2019[51]

The Acting General Manager of Toxicology, in exercise of the powers conferred on him by Article 149, point IV, of the Regiment approved in the terms of Annex I to Resolution of the Collegiate Board – RDC No. 255, of 10 December 2018, and in the terms of the applicable legislation.

Article 1. Publish the toxicological reclassification in accordance with the provisions of Resolution of the Collegiate Board – RDC No. 294, of 29 July 2019.

Article 2. This Resolution shall enter into force on the date of its publication.

Below is the table relating the comparison between the old and new toxicological classifications, in accordance with the international GHS criteria and the technical guidelines of Anvisa.

Table 42. Update of the Anvisa reclassification

Old classification	New classification
CLASS I	
Extremely toxic: Causes skin corrosion. In the eyes, it causes corneal opacity	**Extremely toxic**: Fatal if swallowed, in contact with the skin or inhaled

[51] Available at: https://in.gov.br/web/dou/-/resolucao-re-n-2080-de-31-de-julho-de-2019-208203097

Old classification	New classification
reversible within seven days or not, as well as conjunctival redness and eyelid swelling, which may be reversible or irreversible.	**Highly toxic**: Fatal if swallowed, in contact with the skin or inhaled. The difference from the worst grade lies in the amount necessary to cause the effect.
CLASS II	
Highly toxic: Causes severe skin irritation. In the eyes it does not cause corneal opacity, only reversible irritation, which may be reversible or irreversible.	**Moderately toxic**: Causes irritation if swallowed, in contact with the skin or inhaled.
CLASS III	
Medium toxicity: Causes moderate skin irritation. In the eyes, it does not cause corneal opacity, only reversible irritation, which may be reversible or irreversible.	**Slightly toxic**: Harmful if swallowed, in contact with the skin or inhaled. **Unlikely to cause acute harm**: May be harmful if swallowed, in contact with the skin or inhaled.
CLASS IV	
Slightly toxic: May cause slight skin irritation. In the eyes, it does not cause corneal opacity, only reversible irritation, which may be reversible or irreversible.	**Not classified**: No risks or recommendations.

In view of the above, the Methodology provides for three indicators relating to the level of detail in the recording of the use of agrochemicals in the Project Area, namely: Scenario 1, Scenario 2 and Scenario 3, which allow an assessment of the use of agrochemicals in line with the good practices adopted in the project.

It is emphasized that only one of the three is applicable in a Project Area with the same agricultural practices, with the developer being required to choose the most appropriate scenario for the project's context and to justify that choice in the CR and MR.

It is emphasized that:

i. Cartographic products and/or records with geo-referenced data must be presented in an appropriate form to illustrate the scenarios considered.
ii. The entire method of obtaining the indicator must be described in a clear and verifiable manner;
iii. For this indicator, the rigor in the use of data presented above in the description of the previous indicators must be followed;
iv. Images and supporting accounts must be included in the relevant Reports.

5.3.1.1 AGROCHEMICALS – SCENARIO 1 (I_{AC1})

To obtain the **Agrochemicals Indicator – Scenario 1 (I_{AC1})**, the developer must take into account the following steps:

i. Present in table format the total number of agrochemical products used, specifying:
    a. Commercial name
    b. Chemical composition
    c. Purpose of use

ii. Describe which Categories each product belongs to, based on the toxicological reclassification of Anvisa (RDC No. 294/2019), in accordance with the categories set out below:
    a. Class I – Extremely toxic
    b. Class I – Highly toxic
    c. Class II – Moderately toxic
    d. Class III – Slightly toxic
    e. Class III – Unlikely to cause acute harm
    f. Class IV – Not classified
iii. In the case of products that are not categorized based on Anvisa's toxicological reclassification, the developer must provide:
    a. Chemical composition
    b. Purpose of use
iv. Group the Categories into the four methodological classes set out in Table 43.

Table 43. Scoring for the Agrochemicals Indicator – Scenario 1.

Scenario	Acronym	Score
Agrochemical Indicator – Scenario 1	I_{AC1}	Lowest value among C_1, C_2, C_3, C_4 or C_5
Class I – Extremely toxic and Highly toxic	C_1	0.013
Class II – Moderately toxic	C_2	0.025
Class III – Slightly toxic and Unlikely to cause acute harm	C_3	0.038
Class IV – Not classified	C_4	0.050

Perennial crops that dispense with the use of agrochemicals throughout the production chain, including the preparation of the area, planting, crop management and harvest, will receive the maximum score (5) for the Agrochemicals Indicator – Scenario 1. However, the use of products not registered for the crop must be weighted by a reduction factor, so as to reflect the risk associated with the inappropriate use of agrochemicals in the Project Area.

5.3.1.2 AGROCHEMICALS – SCENARIO 2 (I_{AC2})

To obtain the **Agrochemicals Indicator – Scenario 2 (I_{AC2})**, the developer must take into account the following steps:

i. Present in table format the total number of agrochemical products used, specifying:
    a. Commercial name
    b. Chemical composition
    c. Purpose of use
ii. Describe which Categories each product belongs to, based on the toxicological reclassification of Anvisa (RDC No. 294/2019), in accordance with the categories set out below:
    a. Class I – Extremely toxic
    b. Class I – Highly toxic

c. Class II – Moderately toxic
d. Class III – Slightly toxic
e. Class III – Unlikely to cause acute harm
f. Class IV – Not classified

iii. Group the Categories into the four methodological classes set out in Table 43.
iv. Declare all the values for the calculation of the total proportion of use of each category of agrochemical, in accordance with the equations below:

Equation 18. Proportion of the number of agrochemicals applied by category of Class i.

$$P_{TAC,i} = \left(\frac{N_{TA,i}}{N_{TA}} x\ 100\right)$$

Where:

Table 44. Parameters for the equation of the proportion of agrochemicals applied by category of Class.

$P_{TAC,\ i}$	=	Percentage (%) of agrochemicals applied that belong to class i (i = 1, 2, 3, 4)
$N_{TA,\ i}$	=	Total number of agrochemicals classified in class i
N_{TA}	=	Total number of agrochemicals applied (sum of all classes)

Accordingly, the scoring of the total proportion of use of each agrochemical category will be given as set out in the table below:

Table 45. Scoring for the total proportion of use of each agrochemical category.

Agrochemicals by class	Scale	Score
P_{TAC1}; P_{TAC2}	$0 \leq P_{TAC,\ i} \leq 15\%$	1
	$16\% \leq P_{TAC,\ i} \leq 30\%$	0.8
	$31\% \leq P_{TAC,\ i} \leq 50\%$	0.6
	$51\% \leq P_{TAC,\ i} \leq 70\%$	0.4
	$P_{TAC,\ i} > 71\%$	0.2
P_{TAC3}; P_{TAC4}	$0 \leq P_{TAC,\ i} \leq 15\%$	0.6
	$16\% \leq P_{TAC,\ i} \leq 30\%$	0.7
	$31\% \leq P_{TAC,\ i} \leq 50\%$	0.8
	$51\% \leq P_{TAC,\ i} \leq 70\%$	0.9
	$P_{TAC,\ i} > 71\%$	1

With the scores assigned, the final score of the total proportion of use of each category of agrochemicals is obtained, using the equation below:

Equation 19. Total proportion of use of each agrochemical category.

$$P_{FTA} = score\ of\ P_{TAC1} \times score\ of\ P_{TAC2} \times score\ of\ P_{TAC3} \times score\ of\ P_{TAC4}$$

Where:

P_{FTA}	=	Final Total Proportion of Agrochemicals
P_{TACi}	=	Values extracted from Table 45

For cases in which the products are not categorised based on Anvisa's toxicological reclassification, the developer must:

i. Present, in table format:
   a. Chemical composition
   b. Purpose of use
   c. Quantity used, in liters or in kilograms
ii. Declare the total quantity of agrochemicals used, in liters or in kilograms, and the total productive area in hectares, for the calculation of the proportion of agrochemicals applied, per total productive area, in accordance with Equation 18:

Equation 20. Proportion of agrochemicals applied, in liters and in kilograms, per total productive area.

$$P_{AA} = \frac{(Q_{TAUl} + Q_{TAUkg})}{Q_{TAPha}}$$

Where:

Table 46. Parameters for the equation of proportion of agrochemicals applied, in liters and in kilograms, per total productive area.

P_{AA}	=	Proportion of agrochemicals applied per total productive area
Q_{TAUl}	=	Total quantity of agrochemicals used, of all Classes, in liters
Q_{TAUkg}	=	Total quantity of agrochemicals used, of all Classes, in kilograms
Q_{TAPha}	=	Total quantity of productive area, in hectares

Accordingly, the scoring of the proportion of agrochemicals applied, in liters and in kilograms, per total productive area, will be given as set out in the table below:

Agrochemicals by class	Scale	Score
P_{AA}	$P_{AA} \leq 50$	1
	$51 \leq P_{AA} \leq 100$	0.8
	$101 \leq P_{AA} \leq 200$	0.6
	$201 \leq P_{AA} \leq 300$	0.4
	$P_{AA} > 300$	0.2

With the scores assigned, the final score of the proportion of agrochemicals applied, in liters and in kilograms, per total productive area is obtained, in accordance with the table below:

Table 47. Scoring for the Agrochemicals Indicator – Scenario 2.

Scenario 2	Acronym	Score
Agrochemical Indicator – Scenario 2	I_{AC2}	$\frac{P_{FTA} + P_{AA}}{2}$

Perennial crops that dispense with the use of agrochemicals throughout the production chain, including the preparation of the area, planting, crop management and harvest, will receive the maximum score (5) for the Agrochemicals Indicator – Scenario 2.

5.3.1.3 AGROCHEMICALS – SCENARIO 3 (I_{AC3})

To obtain the **Agrochemicals Indicator – Scenario 3 (I_{AC3}),** the developer must take into account the following steps:

ii. Present in table format the total number of agrochemical products used, specifying:
   a. Commercial name
   b. Chemical composition
   c. Purpose of use

iii. Describe which Categories each product belongs to, based on the toxicological reclassification of Anvisa (RDC No. 294/2019), in accordance with the categories set out below:
   a. Class I – Extremely toxic
   b. Class I – Highly toxic
   c. Class II – Moderately toxic
   d. Class III – Slightly toxic
   e. Class III – Unlikely to cause acute harm
   f. Class IV – Not classified

iv. Group the Categories into the four methodological classes set out in Table 43.

v. Declare all the values for the calculation of the total proportion of use of each Category of agrochemical, in accordance with the equations below:

Equation 21. Proportion of the number of agrochemicals applied by category of Class.

$$P_{TAC,i} = \left(\frac{N_{TA,i}}{N_{TA}} x\ 100\right)$$

Where:

Table 48. Parameter for the equation of the proportion of agrochemicals applied by category of Class.

$P_{TAC,\,i}$	=	Percentage (%) of agrochemicals applied that belong to class i (i = 1, 2, 3, 4)
$N_{TA,\,i}$	=	Total number of agrochemicals classified in class i
N_{TA}	=	Total number of agrochemicals applied (sum of all classes)

Accordingly, the scoring of the proportion of the number of agrochemicals applied by category of class will be given as set out in the table below:

Table 49. Scoring of the proportion of the number of agrochemicals applied by category of Class.

	Scale	Score
P_{TAC1}; P_{TAC2}	$0 \leq P_{TAC,\,i} \leq 15\%$	1
	$16\% \leq P_{TAC,\,i} \leq 30\%$	0.8
	$31\% \leq P_{TAC,\,i} \leq 50\%$	0.6
	$51\% \leq P_{TAC,\,i} \leq 70\%$	0.4

P_{TAC3}; P_{TAC4}	$P_{TAC, i} > 71\%$	0.2
	$0 \leq P_{TAC, i} \leq 15\%$	0.2
	$16\% \leq P_{TAC, i} \leq 30\%$	0.4
	$31\% \leq P_{TAC, i} \leq 50\%$	0.6
	$51\% \leq P_{TAC, i} \leq 70\%$	0.8
	$P_{TAC, i} > 71\%$	1

With the scores assigned, the final score of the proportion of the number of agrochemicals applied by category of class is obtained, using the equation below:

Equation 22. Total proportion of the number of agrochemicals applied by category of Class.

$$P_{FTA} = score\ of\ P_{TAC1} \times score\ of\ P_{TAC2} \times score\ of\ P_{TAC3} \times score\ of\ P_{TAC4}$$

For cases in which the products are not categorized on the basis of Anvisa's toxicological reclassification, the developer must:

i. Present, in table format:
   a. Chemical composition
   b. Purpose of use
   c. Quantity used, in liters or in kilograms
ii. Declare the total quantity of agrochemicals used, in liters or in kilograms, and the total productive area in hectares, for the calculation of the proportion of agrochemicals applied, per total productive area:

Equation 23. Proportion of agrochemicals applied, in liters and/or in kilograms, per total productive area.

$$P_{AA} = \frac{(Q_{TAUl} + Q_{TAUkg})}{Q_{TAPha}}$$

Where:

Table 50. Parameters for the equation of proportion of agrochemicals applied, in liters and in kilograms, per total productive area.

P_{AA}	=	Proportion of agrochemicals applied per total productive area
Q_{TAUl}	=	Total quantity of agrochemicals used, of all Classes, in liters
Q_{TAUkg}	=	Total quantity of agrochemicals used, of all Classes, in kilograms
Q_{TAPha}	=	Total quantity of productive area, in hectares

Accordingly, the scoring of the proportion of agrochemicals applied, in liters and in kilograms, per total productive area will be given as follows:

Table 51. Scoring of the proportion of agrochemicals applied, in liters and in kilograms, per total productive area.

	Scale	Score
P_{AA}	$1 \leq P_{AA} \leq 50$	1
	$51 \leq P_{AA} \leq 100$	0.8
	$101 \leq P_{AA} \leq 200$	0.6
	$201 \leq P_{AA} \leq 300$	0.4
	$P_{AA} > 300$	0.2

Furthermore, for the composition of the Scenario 3 indicator, the number of applications carried out in the 365-day period must be declared, with the mean of product applied, per Toxicity class, in liters and kilograms, per total productive area, being calculated using the equation below:

Equation 24. Average product applied, per Toxicity class, in liters and kilograms, per total productive area, over a 365-day period.

Scenario 3	Acron ym	Equation
Class I, II, III, IV	M_{Ci} =	$M_{Ci} = \frac{\left(\frac{Q_{Ci,l} + Q_{Ci,kg}}{Q_{TAPha}}\right)}{N_{ATC,i}}$

Where:

Table 52. Parameters for the equation of Average product applied, per Toxicity class, in liters and kilograms, per total productive area, over a 365-day period.

M_{Ci}	Mean of agrochemicals of class i, in liters and/or kilograms, per total productive area, per application, over a 365-day period
$Q_{Ci,l}$	Total quantity of agrochemicals of class i, in liters, applied over 365 days
$Q_{Ci,kg}$	Total quantity of agrochemicals of class i, in kilograms, applied over 365 days
Q_{TAPha}	Total productive area, in ha
$N_{ATC,i}$	Total number of applications of agrochemicals of class i carried out over the 365-day period

With the presentation of those data and values defined by class, the scoring of the classes is obtained, in accordance with the table below:

Table 53. Scoring of the Average product applied, per toxicity class, in liters and kilograms, per total productive area.

Class	Scale	Score
M_{C1}; M_{C2}; M_{C3}; M_{C4}	$0 \leq M_{Ci} \leq 10$	1.0
	$11 \leq M_{Ci} \leq 30$	0.8
	$31 \leq M_{Ci} \leq 50$	0.6
	$51 \leq M_{Ci} \leq 100$	0.4
	$M_{Ci} > 100$	0.2

Lastly, the score for the Agrochemicals Indicator in Scenario 3 is obtained. The final score of the indicator will be the lowest value among the scores of the classes, in accordance with the table below:

In cases in which the producer additionally evidences the use of best application practices, as set out below, a compensation factor may be applied to the final score of the indicator, in accordance with Equation 25 below, by virtue of the additional effort.

- Detailed registration of agrochemicals with institutions or associations relevant to the crop cultivated;
- Compliance with specific indications of dose and rotation of chemical groups,
- Appropriate use of Personal Protective Equipment (PPE) in the application and handling of the agrochemical;
- Precise definition of the application target, evidenced by maps and/or spatial cadastral records.

If the result of the final score exceeds 1, the value is capped at that maximum.

Equation 25. Scoring for the Agrochemicals Indicator – Scenario 3: Applicable to cases with proven adoption of good application practices.

Scenario 3	Acronym	Score
Agrochemicals Indicator – Scenario 3	I_{AC3}	$\left[\frac{P_{FTA} + P_{AA} + \frac{(M_{C1} + M_{C2} + M_{C3} + M_{C4})}{4}}{3}\right] \times 1{,}5$

In cases in which the producer cannot present such valid evidence of complementary best practices, the final score of the indicator must be calculated in accordance with Equation 26.

Equation 26. Scoring for the Agrochemicals Indicator – Scenario 3: Applicable to cases without evidence of good application practices.

Scenario 3	Acronym	Score
Agrochemicals Indicator – Scenario 3	I_{AC3}	$\frac{P_{FTA} + P_{AA} + \frac{(M_{C1} + M_{C2} + M_{C3} + M_{C4})}{4}}{3}$

Perennial crops that dispense with the use of agrochemicals throughout the production chain, including the preparation of the area, planting, crop management and harvest, will receive the maximum score (1) for the Agrochemicals Indicator – Scenario 3. However, the use of products not registered for the crop should be weighted by a reduction factor, equivalent to 0.5 of the final score.

5.3.2 WATER RESOURCES IN AGRICULTURAL PRACTICES

As the use of water resources is a fundamental part of the agricultural cultivation process, the Methodology assesses the efficient use of water, the impact of cultivated areas on water quality, water sustainability in agriculture and water infiltration and run-off, to promote good water-management practices in the Project Area.

5.3.2.1 IMPACT OF ARABLE AREAS ON WATER QUALITY (IAAWQ)

Preservation of water quality is a crucial aspect of environmental sustainability, particularly in rural areas where agricultural activities may contribute to the degradation of water bodies. The IAAWQ (Impact of Arable Areas on Water Quality) indicator aims to assess the impact of arable areas on the quality of water bodies, considering the physical, chemical and biological parameters of water.

The IAAWQ not only measures water quality by considering its physical, chemical and biological components, but also indirectly scores the effectiveness of conservation and management measures adopted by farmers. The parameters observed in the IAAWQ are the same parameters analyzed in the Water Quality Index (WQI), as shown in Table 55.

In this context, the IAAWQ is a tool for the assessment and incentive of agricultural practices that contribute to the maintenance of water quality in the Project Area, allowing the impact of arable areas on water bodies and the provision of ecosystem services related to water resources to be assessed.

For the calculation of the **IAAWQ Indicator**, the following steps must be taken:

Table 54. Parameters for determination of the IAAWQ.

Identification of water courses	Use Digital Elevation Model (DEM) and topography data to map the hydrographic network of the Project Area, identifying the main water courses and their tributaries. Use the QGIS software to define the flow of rainwater in the study area.
Selection of monitoring points	Upstream: identify the water course closest to the agricultural area upstream, taking into account the direction of the rainwater flow and the morphological characteristics of the terrain. Care must be taken to ensure that a point is not chosen that has direct discharges of waste, pollutants or sediments, so as not to compromise the analysis of water quality. The number of collection points to be defined is directly related to the characteristics of the Project Area, the extent of the cultivated area and the hydrographic network, with collection being recommended at representative points of the watershed.[52] Downstream: identify the water course closest to the agricultural area that receives the rainwater flow, taking into account the direction of the flow and the hydrographic network. Take into account the direction of the rainwater flow and its trajectory until it reaches the water course that receives the flow, so as to ensure the representativeness of the sample. Use precipitation and surface run-off data to determine the water course that receives the flow of the rainwater, so as to ensure the representativeness of the sample. Sample collection must be carried out upstream and downstream of the tributary to allow the comparison of water quality and the identification of the impact of the arable areas on water quality.[53]
Classification of water quality	Calculate and define the WQI ranges for each sample, in accordance with Equation 27, Equation 28. Table 55 and Table 56

[52] CETESB – São Paulo State Environmental Agency. National Guide to the Collection and Preservation of Samples: water, sediment, aquatic communities and liquid effluents. São Paulo: CETESB; ANA, 2012. 326 p. Available at: https://cetesb.sp.gov.br/wp-content/uploads/2021/10/Guia-nacional-de-coleta-e-preservacao-de-amostras-2012.pdf. Accessed on: 10 December 2024.

[53] CETESB – São Paulo State Environmental Agency. National Guide to the Collection and Preservation of Samples: water, sediment, aquatic communities and liquid effluents. São Paulo: CETESB; ANA, 2012. 326 p. Available at: https://cetesb.sp.gov.br/wp-content/uploads/2021/10/Guia-nacional-de-coleta-e-preservacao-de-amostras-2012.pdf. Accessed on: 10 December 2024.

Frequency of measurement	Classify the water quality at the upstream and downstream points, in accordance with the ranges established in the WQI, so as to allow the comparison of water quality and the identification of the impact of the arable areas on water quality. Upstream: choose the sample with the best WQI Downstream: choose the sample with the worst WQI At least one batch of samples per: wettest period of the year (according to historical precipitation data) and driest period of the year (according to historical precipitation data), so as to allow the assessment of water quality in different seasonal scenarios.

The main way to assess water quality in Brazil is through the Water Quality Index (WQI), which is a composite indicator that integrates nine physical, chemical and biological parameters of water: dissolved oxygen, thermotolerant coliforms, hydrogen potential (pH), Biochemical Oxygen Demand ($BOD_{5,20}$), temperature, total nitrogen, total phosphorus, turbidity and total residue. The equation for the calculation of the WQI is presented below: [54]

Equation 27. Calculation of the WQI.

$$WQI = \prod_{i=1}^{n} q_i^{w_i}$$

Where:

WQI	=	Water Quality Index, a number between 0 and 100
q_i	=	quality of the i-th parameter, a number between 0 and 100, obtained from the respective "mean quality variation curve", set out in Annex II;
w_i	=	weight corresponding to the i-th parameter, a number between 0 and 1, assigned as a function of its importance in water quality.

For w_i, the following applies:

Equation 28. Condition of w_i.

$$\sum_{i=1}^{n} w_i = 1$$

Where:

n	=	number of parameters entering into the calculation of the WQI

The table below sets out the weights to be used.

[54] ANA – National Water and Basic Sanitation Agency. Water Quality Indicators and Index. Available at: http://pnqa.ana.gov.br/indicadores-indice-aguas.aspx#_ftn1. Accessed on: 10 December 2024.

Table 55. Table of water quality parameters.

Water Quality Parameter	Weight (w)
Dissolved oxygen	0.17
Thermotolerant coliforms	0.15
Hydrogen potential – pH	0.12
Biochemical Oxygen Demand – BOD5,20	0.10
Water temperature	0.10
Total nitrogen	0.10
Total phosphorus	0.10
Turbidity	0.08
Total residue	0.08

These measurements must be carried out in situ or by sample collection, within the Project Area, at the downstream points of the water courses that receive the flow of rainwater from the agricultural area.

From the values obtained for each parameter, the quality of each parameter (qi) may be obtained by interpolation of the mean quality variation curve of the parameter, set out in Annex II. Mean water quality variation curves.

From the "qi" and "w" of each parameter, the WQI of the water sample (WQI_f) must be calculated. The WQI range is determined in accordance with the table below.

Table 56. WQI ranges.

Description	Score
$WQI_f \leq 36$	1
$36 < WQI_f \leq 51$	3
$51 < WQI_f \leq 79$	4
$79 < WQI_f \leq 100$	5

Accordingly, the score of the IAAWQ Indicator must be obtained as follows:

Table 57. Scoring for the Impact of Arable Areas on Water Quality Indicator (IAAWQ).

Indicator	Description	Score
Impact of Arable Areas on Water Quality	Without quantification	0
	Downstream sample WQI range < Upstream sample WQI range	1
	Downstream sample WQI range = Upstream sample WQI range	3
	Downstream sample WQI range > Upstream sample WQI range*	5

*If the upstream water quality is classified as the highest possible (score 5, in accordance with the WQI ranges), the downstream sample must be classified as equal for the scoring of the indicator to reach the maximum, since a value higher than the upstream maximum is not possible.

This detailed approach to the selection of monitoring points aims to ensure that the chosen points are representative of the impact of the arable areas on water quality, allowing the verification of the provision of ecosystem services related to water resources.

It is emphasized that:

- All water-resource data used must be obtained from official databases of recognized quality, such as those of the National Water and Sanitation Agency (ANA) and of the state environmental agencies.
- Cartographic products must be presented in an appropriate form to illustrate the scenarios;
- The entire method of obtaining the indicator must be described in a clear and verifiable manner;
- It is recommended to avoid the analysis in a single sample, taking into account the process of self-purification[55] of water, which may give rise to significant variations in water quality along the water body;
- Where the number of samples to be collected is limited by restrictions of time and cost, composite sampling is used, which allows the analysis of water quality in different points of the Project Area.[56].

Analysis of groundwater

In areas with the presence of wells, in addition to the Water Quality Indicator analysis in Agricultural Environments, the analysis of groundwater is necessary, which allows the assessment of the impact of the arable areas on the quality of groundwater and the provision of ecosystem services related to water resources.

Furthermore, the analysis of groundwater, especially in regions that make use of fertilizers and agrochemicals, is fundamental for the assessment of the impact of arable areas on the quality of groundwater and the provision of ecosystem services related to water resources.[57]

Nitrite ions present in water intended for human consumption have more rapid adverse effects than those of nitrate[58], thus making their assessment necessary. Nitrate, in turn, has high solubility in water and is mobile in the soil, which may give rise to contamination of groundwater and water bodies[59]. Accordingly, it is recommended that the analysis of nitrite and nitrate be prioritized in samples of groundwater, especially in regions with intensive use of fertilizers and agrochemicals.

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[55] BATALHA, Ben-Hur Luttembarck; ROCHA, Aristides Almeida. Self-purification of watercourses. Revista DAE, vol. 144, no. 157, pp. 40–46, March 1986. Available at: https://revistadae.com.br/artigos/artigo_edicao_144_n_157.pdf. Accessed on: 11 December 2024.

[56] EMBRAPA. Manual of procedures for water sampling and physical-chemical analysis. Embrapa, 2011. Accessed on: 12 December 2024.

[57] SILVA, José Carlos da; REIS, Luis Roberto Rocha; BORGES, Izabel Cristina Pereira. Nitrate levels in groundwater in the State of São Paulo. Journal of the Geological Institute, São Paulo, vol. 40, no. 3, pp. 1–12, 2019. DOI: 10.33958/revig.v40i3.672. Available at < https://revistaig.emnuvens.com.br/rig/article/view/672/637 >. Accessed on: 11 December 2024.

[58] CARDOSO, Juarez Marques; AMÉRICO-PINHEIRO, Juliana Heloisa Pinê; RIBEIRO, Lucíola Guimarães. Analysis of nitrite in groundwater for human consumption in Campo Grande – MS. In: 22nd BRAZILIAN SYMPOSIUM ON WATER RESOURCES, 2017, Foz do Iguaçu. Proceedings... Foz do Iguaçu: Brazilian Association of Water Resources, 2017. pp. 1–12. Available at < https://files.abrhidro.org.br/Eventos/Trabalhos/60/PAP023163.pdf >. Accessed on: 17 December 2024.

[59] SILVA, José Carlos da; REIS, Luis Roberto Rocha; BORGES, Izabel Cristina Pereira. Nitrate levels in groundwater in the State of São Paulo. Journal of the Geological Institute, São Paulo, vol. 40, no. 3, pp. 1–12, 2019. DOI: 10.33958/revig.v40i3.672. Available at < https://revistaig.emnuvens.com.br/rig/article/view/672/637 >. Accessed on: 11 December 2024.

Should analyses of additional substances be carried out, both in surface and groundwater, the results must be presented in a clear and verifiable manner, with justification for the choice of the parameters analyzed and the relevance of those parameters for the assessment of water quality.

All water sample analyses, whether from surface or groundwater sources, must be carried out in accordance with the technical guidelines of the National Water and Sanitation Agency (ANA) and of the state environmental agencies, so as to ensure the accuracy and reliability of the results.

5.3.2.2 WATER SUSTAINABILITY IN AGRICULTURE (WSA)

The Water Sustainability in Agriculture (WSA) Indicator was developed to recognise and assess the adoption of agricultural practices that contribute to **the mitigation of pollution** of water bodies, both surface and groundwater. Mitigating the dispersion of macronutrients, such as nitrogen and phosphorus, is fundamental to prevent the eutrophication of water bodies and to ensure the quality of water for human consumption and for agricultural use.

This indicator recognizes the agricultural practices that contribute to the mitigation of pollutants that may impair the quality of water bodies, such as the use of sustainable agricultural practices, the management of waste and the adoption of water conservation measures.

The implementation of sustainable agricultural practices is internally associated with the preservation of the quality of water and the provision of ecosystem services. The table below sets out the classification of the agricultural practices[60] that may be implemented in the Project Area.

[60] LOGAN, Terry J. Agricultural best management practices for water pollution control: current issues. Agriculture, Ecosystems & Environment, vol. 46, no. 1–4, pp. 223–231, Sept. 1993. Available at: https://www.sciencedirect.com/science/article/abs/pii/016788099390026L. Accessed on: 16 December 2024.

Table 58. Classification of agricultural practices.

	Agricultural practices	Benefits	Description
Structural	Surface drains	Water quality; Control of nitrogen in the soil.	Surface drains in agricultural areas are consumption systems designed to remove excess water from the soil[61], with the aim of preventing waterlogging and improving the conditions for cultivation. Those drains may be constructed in the form of open ditches or buried pipes, depending on the characteristics of the soil and the topography.
	Irrigation wastewater recovery system	Control of erosion and sediments in water and soil.	Water reuse consists of the use of water previously used in one or more activities, with appropriate treatment, for irrigation or other agricultural uses. The reuse of water contributes to the reduction of water demand and to the control of the erosion and sediments in water and soil.[62].
	Sediment and water retention basins	Eutrophication control; Water quality	Retention basins are widely used for water storage for agricultural activities, allowing the control of eutrophication and water quality.[63].
Cultural	Conservationist cultivation	Control of erosion; eutrophication; sediments and phosphorus	Conservationist cultivation is a set of agricultural practices that aims to improve soil quality and reduce environmental impacts, through the reduction of tillage, the maintenance of vegetation cover and the rotation of crops.[64].
	Contour cultivation	Control of erosion;	Contour cultivation consists of planting crops transversely to the slope of the land, following the contour lines of the topography, so as to reduce surface run-off and soil erosion.[65].

61 SILVA, Francisco de Assis Almeida da. Drainage Course Notes. Fortaleza: Federal University of Ceará, 2008. Available at: http://www.gpeas.ufc.br/disc/dren/apostila_drenagem.pdf. Accessed on: 17 December 2024.

62 CETESB. Water reuse. CETESB – São Paulo State Environmental Company, [online]. Available at: https://cetesb.sp.gov.br/agua/reuso-de-agua/. Accessed on: 17 December 2024.

63 LIMA, Herlander Mata; SILVA, Evaristo Santos; RAMINHOS, Cristina. Retention basins for runoff management: design and installation methods. Revista Escola de Minas, [online] 2006. Available at: https://www.scielo.br/j/rem/a/xndZLswjWn68zvfNBSCVXjy/. Accessed on: 17 December 2024.

64 LOBATO, Breno. Conservation agriculture: learn about the principles and practices for the Cerrado. Embrapa Cerrados, 27 Nov. 2019. Available at: https://www.embrapa.br/en/busca-de-noticias/-/noticia/48440960/agricultura-conservacionista-conheca-os-preceitos-e-praticas-para-o-cerrado. Accessed on: 17 Dec. 2024.

65 ANTUNES, Joseani M. Contour sowing can reduce water and soil losses due to erosion by 50%. Embrapa Trigo, 9 Nov. 2016. Available at: https://www.embrapa.br/en/busca-de-noticias/-/noticia/17952130/semeadura-em-contorno-pode-reduzir-em-50-perdas-de-agua-e-solo-por-erosao. Accessed on: 17 Dec. 2024.

	Agricultural practices	Benefits	Description
		eutrophication; and sediments	
	Strip cultivation	Control of erosion; eutrophication; and sediments	Strip cultivation consists of alternative crops in strips within the cultivated area, promoting the reduction of erosion and the improvement of soil quality.[66]
	Low-input agriculture	Control of erosion; and eutrophication; Water quality; Control of sediments and pesticides.	Low-input agriculture is an agricultural production system that seeks to reduce dependence on external inputs, such as chemical fertilizers and pesticides, through the adoption of sustainable practices and efficient use of natural resources.[67].
	Cover cropping	Control of erosion; and eutrophication; Water quality; Control of sediments	Cover crops are an effective strategy for improving the physical, chemical and biological attributes of the soil, contributing to the reduction of erosion, the improvement of water quality and the conservation of biodiversity.[68].

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[66] EMBRAPA. Soil and Water Conservation Practices. Campina Grande, PB: EMBRAPA, September 2012. (Technical Circular, 133). Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/928493/1/CIRTEC133tamanhografica2.pdf. Accessed on 26 December 2024..

[67] SARKAR, Deepranjan; KAR, Saswat Kumar; CHATTOPADHYAY, Arghya; SHIKHA; RAKSHIT, Amitava; TRIPATHI, Vinod Kumar; DUBEY, Pradeep Kumar; ABHILASH, Purushothaman Chirakkuzhyil. Low-input sustainable agriculture: A viable climate-smart option for boosting food production in a warming world. Ecological Indicators, vol. 115, pp. 1064–12, Aug. 2020. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1470160X20303496. Accessed on: 17 Dec. 2024..

[68] LAMAS, Fernando Mendes. Article – Cover crops: What are they? Embrapa Agropecuária Oeste, 25 Sept. 2017. Available at: https://www.embrapa.br/en/busca-de-noticias/-/noticia/28512796/artigo---plantas-de-cobertura-o-que-e-isto. Accessed on: 17 Dec. 2024..

	Agricultural practices	Benefits	Description
Management	Subsoiling	Salinity control; and sediments.	Subsoiling is an agricultural practice that aims to improve the physical, chemical and biological properties of the soil, through the breaking of compacted layers and the improvement of water infiltration and root development.[69].
	Land levelling	Salinity control; erosion; and sediments.	Land levelling is an essential agricultural practice that aims to adjust the topography of a plot of land, so as to facilitate irrigation and drainage and reduce surface run-off and soil erosion.
	Crop rotation	Control of erosion; and sediments.	Crop rotation is an agricultural practice which consists of alternating different types of crops in the same area, so as to improve soil quality and reduce the incidence of pests and diseases.[70].
	Animal waste management	Animal waste management; Eutrophication control; Water quality; Control of nitrogen, phosphorus and pathogens.	Animal waste management in agricultural areas refers to the practice of managing in an appropriate manner the solid and liquid waste generated by the livestock, with the aim of reducing environmental impacts and improving soil and water quality.[71].

[69] RAPER, R.L. Subsoiling. In: Encyclopedia of Soils in the Environment, Reference Module in Earth Systems and Environmental Sciences, 2005. pp. 69–76. Available at:https://www.sciencedirect.com/science/article/abs/pii/B0123485304002678. Accessed on: 17 Dec. 2024.

[70] EMBRAPA. Concepts and benefits of crop rotation. Embrapa, 2021. Available at: https://www.embrapa.br/en/agencia-de-informacao-tecnologica/cultivos/soja/producao/rotacao-de-culturas/conceitos-e-beneficios-da-rotacao-de-cultura. Accessed on: 17 Dec. 2024

[71] EMBRAPA. Animal waste management. Embrapa, 2021. Available at: https://www.bibliotecaagptea.org.br/agricultura/adubacao/livros/TRATAMENTO%20DE%20RESIDUOS%20ANIMAIS%20-%20EMBRAPA.pdf. Acesso em: 17.12.2024.

It is emphasized that, regardless of whether the practice is listed or not in the table set out above, the developer may present other sustainable practices adopted in the Project Area, provided that they are duly justified and documented, allowing the assessment of the indicator.

The scoring of this indicator ranges from 1 to 5, depending on the number of sustainable practices adopted in the Project Area, with each practice adding 1 point to the scoring of the indicator.

Score

i. If there is no quantification of agricultural practices, the score will be zero;
ii. No practice adopted receives a score of 1;
iii. For each practice adopted, 1 point is added to the indicator, generating the base score, which ranges from 1 to 5, in accordance with the table below:

Table 59. Base scoring for the Water Sustainability in Agriculture Indicator (I_{WSA}).

Indicator	Number of Practices Adopted	Base Score
Water Sustainability in Agriculture	Without quantification	0
	0	1
	1	2
	2	3
	3	4
	4	5

iv. However, the Base Score will subsequently be multiplied by the mean of the factor "q", which assesses the proof of good practices and ranges from 0 to 1, in accordance with the criteria set out below:
   - The factor "q" assesses the proof of good practices and may take the values: 0, 0.5 or 1, in accordance with the following criteria:
     - q = 0.0 (where there is no sufficient proof of the good conditions of the practices)
     - q = 0.5 (where there is proof, but it is incomplete or not entirely satisfactory)
     - q = 1.0, (where everything is adequately proven).
   - Each practice must be assessed individually, taking q = 0, 0.5 or 1. Subsequently, the mean of the factors "q" of the practices adopted must be calculated, which will be used in the calculation of the final score of the indicator.
   - Proof of the good practices must be presented by means of a specific report – or by other appropriate means of evidence – containing the following elements:
     - Photographic records (dated and geo-referenced) proving the implementation and the quality of the practices adopted in the Project Area;
     - Detailed description of each practice, including applicable technical rules. In cases in which there are no specific technical rules, the developer must present a technical justification for the adoption of the practice.

v. Furthermore, for undertakings that adopt more than 4 practices, 0.2 point per additional practice will be added to the final score of the indicator, up to a maximum of 1 point of bonus, in accordance with the table below:

vi. Final score: the final score must be the multiplication between the base score and the (Equation 29) with the possible addition of scoring per additional practice where applicable, taking into account the following provisos:
    - If more than 50% of the practices have “q” ≤ 0.5, the maximum score will be **3, regardless of how many additional practices there are**;
    - If between 25% and 50% of the practices have “q” ≤ 0.5, the maximum score will be **4, regardless of how many additional practices there are**.

Equation 29. Calculation of the Final Score of the WSA indicator.

$$P_F = P_B \times q_{avg} + P_{additional} \times q_{avg\ additional}$$

Where:

P_F	=	Final score of the indicator
P_B	=	Base score of the indicator (prior to multiplication by the factor q_{avg})
q_{avg}	=	Mean of the ‘q’ factors of proof of good practices
$P_{additional}$	=	Sum of the scores relating to additional practices (where there are more than 4 practices adopted)
$q_{avg\ additional}$	=	Mean of the ‘q’ factors of proof of good practices relating to the additional practices

Note: the practices of land levelling, cover cropping and crop rotation, addressed in the context of water sustainability in agriculture, will not be counted in the scoring of the SSM indicator (see item 5.3.3), to avoid double counting.

5.3.2.3 WATER USE EFFICIENCY (WUE)

The supply of water for drinking purposes is a provisioning EcS essential for humanity. A more efficient management of water resources contributes to the maintenance of the EcS and to the reduction of pressure on water bodies[72]. It is emphasised that water is also essential for other EcS, such as the regulation of the stability of ecosystems, the maintenance of biodiversity and the provision of cultural services[73].

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[72] WRI BRASIL. Ranking shows where the risk of water shortages is highest in Brazil and worldwide. WRI Brasil, 6 August 2019. Available at: https://www.wribrasil.org.br/noticias/ranking-mostra-onde-ha-maior-risco-de-faltar-agua-no-brasil-e-no-mundo#:~:text=O%20ranking%20do%20Aqueduct%20identifica,dos%20pa%C3%ADses%20do%20Oriente%20M%C3%A9dio . Accessed on: 17 Dec. 2024.

[73] EMBRAPA. Manual on Payments for Environmental Services (PES) – Chapter 1. Brasília: Embrapa, 2017. Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1074403/1/ManualPSA2017cap1.pdf . Accessed on: 17 Dec. 2024.

Accordingly, water use efficiency plays a crucial role in the maintenance of EcS, which makes the adoption of sustainable practices in the use of water resources in agricultural areas essential[74].

The efficiency of water use in irrigation may present significant variation according to the method used, with more efficient methods, such as drip irrigation, being more suitable for the reduction of water use and for the maintenance of EcS.[75] [76] [77]

In addition to the irrigation system used, the management of the control system also affects the efficiency of water use[78], so that that aspect is also taken into account in this indicator.

In view of this, the subject will be considered by the Methodology as an indicator in accordance with the irrigation method used in the Project Area and the management of the control and monitoring system. To determine the **Water Use Efficiency Indicator**, the Methodology determines the following.

The final score of this indicator is calculated based on (i) the scoring of the irrigation system, (ii) the scoring of the management of the control and monitoring system, and (iii) the scoring of water reuse, in accordance with the tables below.

The **scoring of the irrigation system** follows the table set out below, in accordance with the irrigation method used in the Project Area:

Table 60. Irrigation system scoring for the Water Use Efficiency Indicator (I_{WUE}).

Indicator	Description	System score
Water Use Efficiency	Without qualification of the method	0
	Irrigation by surface flooding	1
	Sprinkler irrigation	2
	Pivot irrigation, whether central or linear	3
	Drip irrigation	4
	Exclusive use of rainwater	5

[74] NATIONAL AGENCY FOR WATER AND BASIC SANITATION (ANA). Water uses. ANA, 2021. Available at: https://www.gov.br/ana/pt-br/assuntos/gestao-das-aguas/usos-da-agua. Accessed on: 17 December 2024.

[75] BATALHA, Ben-Hur Luttembarck; ROCHA, Aristides Almeida. The use of irrigation in Brazil. NEAS Journal, 2005. Available at: https://www1.ufrb.edu.br/neas/images/Artigos_NEAS/2005_3.pdf. Accessed on: 16 December 2024.

[76] ANDRADE, Camilo de Lelis Teixeira de; BRITO, Ricardo Augusto Lopes. Irrigation and Chemigation Methods. Sete Lagoas: Embrapa Maize and Sorghum, 2006. 10 p. (Technical Circular, 86). Available at: https://www.infoteca.cnptia.embrapa.br/bitstream/doc/490418/1/Circ86.pdf. Accessed on: 16 December 2024.

[77] LIMA, Jorge Enoch Furquim Werneck. The use of irrigation in Brazil. Brasília: Embrapa Cerrados, 1999. 20 p. Available at: https://www.researchgate.net/profile/Jorge-Enoch-Lima/publication/228716436_O_uso_da_Irrigacao_no_Brasil/links/00463539b762c64d04000000/O-uso-da-Irrigacao-no-Brasil.pdf. Accessed on: 16 December 2024.

[78] KOECH, Richard; LANGAT, Philip. Improving irrigation water use efficiency: a review of advances, challenges and opportunities in the Australian context. *Water*, v. 10, n. 12, p. 1771, 2018. Available at: https://www.mdpi.com/2073-4441/10/12/1771. Accessed on: 16 December 2024.

In all cases, the developer must present proof of the irrigation method(s) used, such as photographs of the equipment, technical documents or other verifiable evidence.

Regarding the **management of the control and monitoring system**, the scoring assigned is associated with the number of different types of information used in the management of the system, in accordance with the table below:

Table 61. Scoring value for control and monitoring system management.

Number of types of data used	Management score
0	-1
1	0
2 or more	+1

For a type of information to compose the management score, the method of its use in the management of the system must be detailed, as well as the sources of data used and the records of the values monitored in the period assessed.

For the proof of the management methods used in the control of the use and activation of the irrigation systems, the developer must present the following elements:

Document describing the management method adopted, whether internal procedure, operational protocol or other verifiable evidence;

i. Description of the data sources used in the management (such as humidity sensors, tensiometry, meteorological data, among others);
ii. Records of the values monitored in the period assessed, where available, or, alternatively, technical justification for the absence of records;
iii. Complementary evidence, where applicable, such as photographic records or equivalent documents.

For projects that exclusively use rainwater, evidence must be presented proving the exclusive use of rainwater in the Project Area, such as photographs of the collection system, technical documents or other verifiable evidence.

As regards the **reuse score**, it takes the value of 0 or 1. Where there is, within the Project Area, a water reuse system and there is proof of that reuse, the score is 1; otherwise, the score is 0.

The final score of this indicator is the sum of the irrigation system score with the management score and the reuse score, in accordance with the equations and tables set out above.

It is emphasized that:

i. All secondary water-resource data used must be obtained from official databases of recognized quality;
ii. Cartographic products must be presented in an appropriate form to illustrate the scenarios;
iii. The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.3.2.4 WATER INFILTRATION AND RUN-OFF (WIR)

Soil infiltration plays an essential role in the hydrological cycle, promoting various ecosystem benefits, such as the recharge of aquifers, the reduction of surface run-off and the maintenance of water quality in water bodies.

The Curve Number (CN) is a hydrological parameter developed by the Natural Resources Conservation Service (NRCS) of the USDA[79] to estimate the surface run-off potential of an area on the basis of the type of soil, land use and land cover and conditions of hydraulic conductivity.

5.3.2.4.1SOIL CLASSIFICATION

From a hydrological standpoint, soils are classified into four types according to the SCS, ranging from the most sandy to the most clayey, as set out in Table 62.

The first stage consists of the classification of the soil, which may be carried out on the basis of primary or secondary data, in accordance with the guidelines set out below:

a. Primary data

Generally, the primary data derive from a grain-size analysis carried out in a laboratory, determining the proportions of sand, silt and clay in the soil, in accordance with the guidelines of the USDA and of the Brazilian Soil Classification System (SiBCS).

Where there is more than one sample for the Project Area, the mean of the grain-size fractions for each texture is calculated, per sample, using the equation below:

Equation 30. Calculation of the means of the grain-size fractions for each texture, per sample.

$$F_{clay} = \frac{F_{clay(A)} + F_{clay(B)} + \cdots + F_{clay(n)}}{n}$$

$$F_{silt} = \frac{F_{silt(A)} + F_{silt(B)} + \cdots + F_{silt(n)}}{n}$$

$$F_{sand} = \frac{F_{sand(A)} + F_{sand(B)} + \cdots + F_{sand(n)}}{n}$$

Where:

F	=	Grain-size fraction
n	=	Total number of soil samples

[79] Garen, David C. and Daniel S. Moore, 2005. Curve Number Hydrology in Water Quality Modeling: Uses, Abuses, and Future Directions. Journal of the American Water Resources Association (JAWRA) 41(2):377-388. Disponível em: https://www.nrcs.usda.gov/sites/default/files/2023-03/CURVE%20NUMBER%20HYDROLOGY%20IN%20WATER%20QUALITY%20MODELING.pdf. Acesso em 12.12.2024.

After the calculation of the mean grain-size fractions, it is possible to determine the textural class of the soil using the Textural Triangle, which is an internationally recognized tool for the classification of soils on the basis of the proportions of clay, silt and sand.*Soil Conservation Service (SCS)* of the United States[80] That method is widely accepted and recognized by the Brazilian Soil Science Society for the classification of soils on the basis of their physical properties.

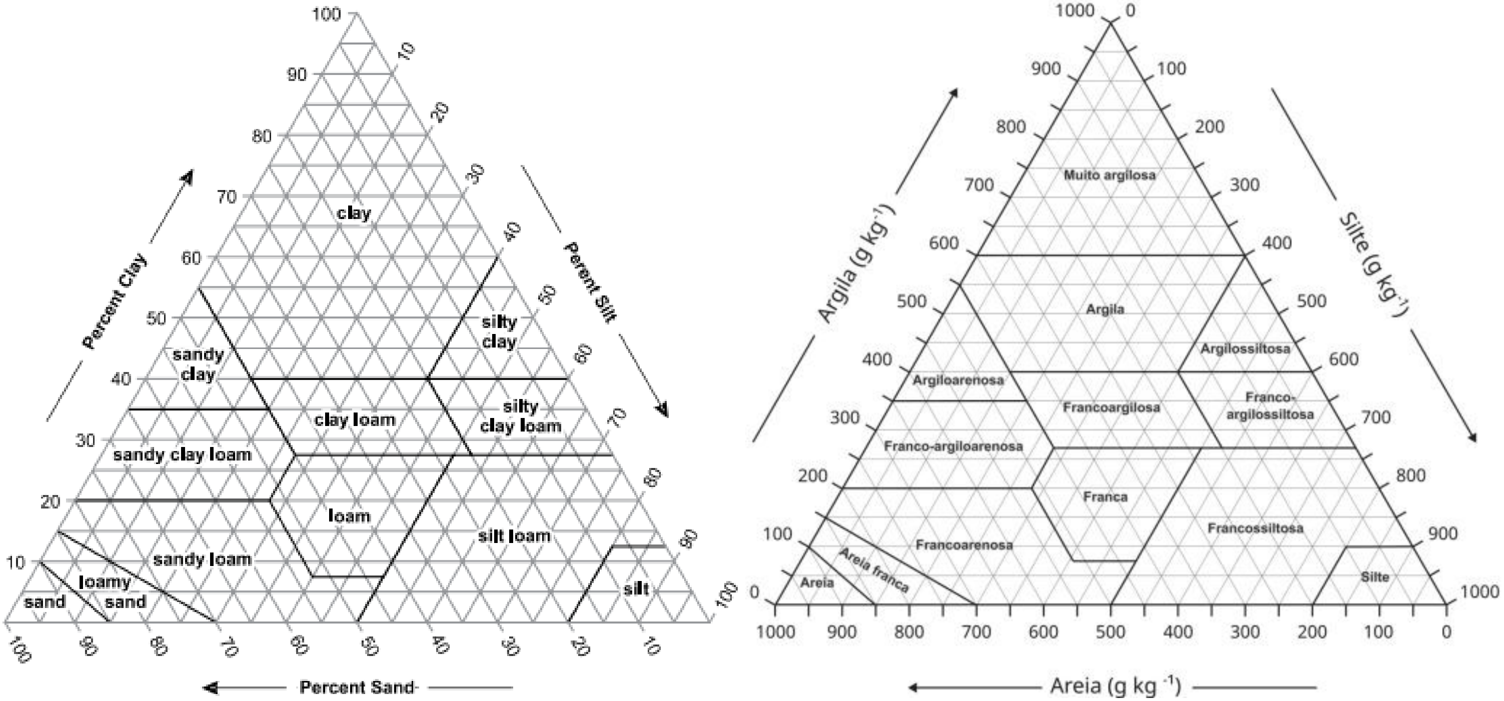
The Textural Triangle presents the proportions of clay, silt and sand, allowing the soil to be classified into the 12 textural classes established by the USDA.

The United States Department of Agriculture (USDA) makes available an online calculator based on the Textural Triangle[81], which allows the classification of the soil to be automated on the basis of the grain-size fractions obtained in the laboratory. Where the online calculator is not used, the textural definition may be carried out manually, using the Textural Triangle and the guidelines of the USDA and of SiBCS. The figure below shows the USDA Textural Triangle and its Brazilian correspondence, allowing the classification of the soil on the basis of the proportions of clay, silt and sand.

[80] Soil Survey Manual. Washington, D.C.: Department of Agriculture, Soil Conservation Service, 437 pp. (USDA Agricultural Handbook, 18) 2nd ed. 1993. Available at: https://www.nrcs.usda.gov/sites/default/files/2022-09/The-Soil-Survey-Manual.pdf. Acesso em: 13 nov. 2025.)

[81] Available at: https://www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-texture-calculator. Accessed on: 18 Dec. 2025.

Figure 4. USDA textural triangle showing the percentages of clay, silt and sand in the 12 basic soil classes established by the USDA.



Source: USDA Textural Triangle – United States (Soil Survey Staff, 1993); Textural triangle used in Brazil – Brazilian Soil Classification System (2025)[82] and De Lemos and Santos (1996)[83].

[82] Brazilian Soil Classification System / Humberto Gonçalves dos Santos [et al.]. – 6th ed., rev. − Brasília, DF: Embrapa, 2025. 393 p. Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1176834/1/Sistema-Brasileiro-de-Classificacao-de-Solos-2025.pdf. Accessed on: 13 Nov. 2025)

[83] DE LEMOS, Raimundo Costa; DOS SANTOS, Raphael David. Manual on soil description and collection in the field. 1996. Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/330369. Accessed on: 17 Dec. 2025.

For a practical example of application of the Textural Triangle, see Annex V. Example application of the textural triangle for soil classification based on the proportions of clay, silt and sand.

After defining the textural class of the soil and adapting it to the Brazilian nomenclature, the correspondence with the hydrological groups is carried out (see item *5.3.2.4.2*). That step is essential because the hydrological groups represent the behavior of the soil in relation to water infiltration and surface run-off, which are fundamental parameters for the calculation of the CN.

b. Secondary data

Where primary data are not available, secondary data from official sources, such as soil maps and technical reports from recognized institutions, may be used, in accordance with the guidelines of Table 62).

It is important to emphasize that primary data must be prioritized whenever available, since they allow a more accurate and representative characterization of the soil of the Project Area.

5.3.2.4.2 DEFINITION OF THE HYDROLOGICAL CLASS OF THE SOIL

To facilitate that conversion, the correspondence table (Table 62) is used, which relates the hydrological groups to the Brazilian soil classes. That table, presented by POMPERMAYER (2013)[84], is compatible with the Brazilian Soil Classification System (SiBCS) and adopted by the National Water and Sanitation Agency (ANA)[85]. It contains the definitions of the hydrological groups and the proposed framework for Brazilian soils.

It is emphasized that, for the definition of the hydrological class, it is necessary first to choose which textural class best represents the soil of the Project Area, based on the primary or secondary data available.

- Textural class (from the textural triangle)
- Main characteristics
- Infiltration rate
- Corresponding soil types in Brazil

The main ways of determining the hydrological class are summarized in the table below:

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[84] SARTORI, Aderson; LOMBARDI NETO, Francisco; GENOVEZ, Abel Maia. Hydrological classification of Brazilian soils for estimating excess rainfall using the United States Soil Conservation Service method. Part 1: Classification. Revista Brasileira de Recursos Hídricos, vol. 10, no. 4, pp. 5–18, 2005. Available at: https://abrh.s3.sa-east-1.amazonaws.com/Sumarios/26/6c2ebe52f7043b800f2879be8e09bd55_624e887e937b744607e1fe0d08b69e6d.pdf. Accessed on: 18 Dec. 2025.

[85] ANA – National Water Agency. Technical Note No. 46/2018/SPR, Document No. 00000.040424/2018-44, 2018. Available at: https://metadados.snirh.gov.br/geonetwork/srv/api/records/d1c36d85-a9d5-4f6a-85f7-71c2dc801a67/attachments/NOTA_TECNICA_46_2018_SPR.pdf. Accessed on: 18 Dec. 2025.

Table 62. Hydrological classes of Brazilian soils.

Hydrological Class	Textural class (from the textural triangle)	Main Characteristics	Infiltration Rate	Corresponding Soil Types in Brazil
Soil A	Sand Loamy sand Sandy loam	High infiltration and low surface run-off. Sandy, deep and highly drained soils.	> 7.62 mm/h	YELLOW, RED-YELLOW and RED LATOSOLS (clayey or very clayey texture, highly permeable).
Soil B	Silty loam Loam	Moderate permeability, with above-average infiltration. Deep to moderately deep soils, with medium texture.	3.81 - 7.62 mm/h	YELLOW and RED-YELLOW LATOSOLS (medium texture with sandy surface horizon).
Soil C	Sandy clay loam	Below-average infiltration and greater surface run-off. Moderately fine texture, shallow soils.	1.27 - 3.81 mm/h	Shallow ARGISOLS without abrupt textural change; RED, RED-YELLOW ARGISOLS and others.
Soil D	Very clayey (where there is more than 60% clay) Clay Sandy clay Silty clay Silty clay loam	Very low infiltration and high potential for surface run-off. Expansive clayey soils.	< 1.27 mm/h	LITHIC NEOSOLS; ORGANOSOLS; GLEISOLS; CHERNOSOLS; PLANOSOLS; VERTISOLS; and other soils with low permeability.

Source: Adapted from ANA (2018) and POMPERMAYER (2013).[86]

5.3.2.4.3 DEFINITION OF LAND USE AND OCCUPATION

The WIR indicator aims to promote good soil management and land-use planning practices, taking into account the classification of the soil and of land use in the Project Area.

The methodology includes the classification of the soil and of land use, using tools such as:

i. QGIS, Mapbiomas and satellite imagery to identify the type and use of the soil in the analysis area;
ii. Information collected from official secondary data;
iii. And, where possible, validations carried out in the field.

[86] POMPERMAYER, Rafael do Carmo. Hydrological modelling: geoprocessing techniques applied to the SCS (Soil Conservation Service) Curve Number model. Belo Horizonte: Federal University of Minas Gerais, 2013. Available at: https://www.nrc.gov/docs/ML1421/ML14219A437.pdf, Acesso em 17.12.2024

It is important to emphasize that, during the analysis, adjustments may be necessary in the classification of the soil and of land use, in accordance with the specific conditions of the Project Area and the data available.

Table 63. Curve Number values for rural areas.

CN values for rural areas.					
Land use and occupation classes (ANA, 2018)	Mapbiomas equivalent (Collection 10)	Hydrological class of the soil			
		A	B	C	D
Artificial area	Urbanized area, Mining, Photovoltaic plant, Other non-vegetated areas*	93	93	93	93
Agricultural area	Temporary Crop, Perennial Crop	64	76	84	88
Managed pasture	Pasture*	6	35	70	79
Mosaic of Agricultural Area with Forest Remnants	Use mosaic*	60	76	85	90
Silviculture	Silviculture	26	52	62	69
Forest Vegetation	Forest Formation, Savanna Formation	36	60	70	76
Mosaic of Forest Vegetation with Agricultural Activity	Use mosaic*	55	72	81	86
Grassland Vegetation	Grassland Formation, Apicum, Rocky Outcrop, Herbaceous Restinga	30	58	71	78
Wetland Area	Mangrove, Flooded Forest, Arboreal Restinga, Flooded Grassland and Swamp Area	95	95	95	95
Natural pasture	Pasture*	36	60	73	79
Mosaic of Agricultural area with Grassland Remnants	Use mosaic*	47	67	78	83
Inland Water Body	River, lake, Aquaculture	100	100	100	100
Coastal Water Body	Ocean	100	110	100	100
Uncovered Area	Beach, Dune and Sandy area, Other Non-Vegetated Areas*	74	84	90	92

Source: Adapted from ANA (2018), POMPERMAYER (2013) and USDA (1986)[87]. *The Use mosaic, Pasture and Other non-vegetated areas classes, in accordance with the MapBiomas Collection 10 classification, may require complementary analysis, which must be carried out with the support of additional secondary data and/or field validations, so as to ensure the accuracy of the classification. In the case of the Use mosaic class, specifically, the developer may, at its discretion, consider the values set out in Table 63. Where it is not possible to carry out that complementary analysis, the adoption of the values set out in the table above is recommended.

Table 64. Curve Number values for urban areas.

CN values for urban areas					
Land use	Density of impermeable area (%)	Soil Type			
		A	B	C	D
Paved areas	100	98	98	98	98
Residential lots 2000m²	30	61	75	83	87
Residential lots 1000m²	38	65	79	86	90
Residential lots 500m²	65	77	85	90	92

[87] USDA, 1986. Urban Hydrology for Small Watersheds: TR-55. United States Department of Agriculture, Natural Resources Conservation Service (NRCS), 2nd ed., 1986.

Land use	CN values for urban areas Density of impermeable area (%)	Soil Type A	B	C	D
Commercial areas	85	89	92	94	95
Industrial areas	72	81	88	91	93
Urban parks areas	15	49	69	79	84
Grassed central reservations	20	57	73	81	86

Source: Adapted from ANA (2018), POMPERMAYER (2013) and USDA (1986).

5.3.2.4.4 DEFINITION OF THE CN

Based on that information, the mean CN weighted by the proportion of each type of land use and occupation is calculated, to obtain the final value of the CN for the Project Area. The step-by-step procedure for determining the mean CN of the study area is as follows:

- **Data Collection**

  a. Soil type: Classify the soil as A, B, C or D, in accordance with its characteristics. Use Table 62 as a basis. Official secondary data or primary data may be used;
  b. Land use: Identify the land use and cover in the study area:
     i. That analysis may be carried out on the basis of satellite imagery, drone imagery, MapBiomas, or other sources of information.
     ii. If necessary, after the analysis of land use and cover, correlate what was mapped with the categories presented in Table 63 or Table 64;
     iii. Carry out the delimitation of polygons by land use in software such as QGis, Google Earth;
     iv. Carry out the delimitation of polygons by soil class (A, B, C or D) in software such as QGis, Google Earth;
     v. Carry out the overlay between the polygons by land use *x* polygons by soil class, generating new polygons that contain both items of information;
     vi. Calculate the area of each of the new polygons generated from the combination of the polygons by land use and soil class;
     vii. Sum all the areas that have the same soil type and land use and determine the proportion in relation to the total area of the Project Area;
     viii. For the assistance of the calculation, complete the table below and resolve Equation 31.

Table 65. Determination of the weighted Curve Number for different land-use types.

i	Hydrological Class (Soils A, B, C or D)	Land use	Corresponding CN (CN_i)	Total area of the corresponding CN (A_i)	Proportion in relation to the total area (A_{ip})	CN weighted by land use (CN_{ip})
1	(Soils A, B, C or D)		CN_1	= ∑areas corresponding to the same CN	$A_{1p} = \frac{A_1}{Total\ area}$	$CN_{ip} = CN_1 \times A_{1p}$

i	Hydrological Class (Soils A, B, C or D)	Land use	Corresponding CN (CN_i)	Total area of the corresponding CN (A_i)	Proportion in relation to the total area (A_{ip})	CN weighted by land use (CN_{ip})
2	(Soils A, B, C or D)		CN_2	= ∑areas corresponding to the same CN	$A_{2p} = \frac{A_2}{Total\ area}$	$CN_{ip} = CN_2 \times A_{2p}$
3	(Soils A, B, C or D)		CN_3	= ∑areas corresponding to the same CN	$A_{3p} = \frac{A_3}{Total\ area}$	$CN_{ip} = CN_3 \times A_{3p}$
...	...	...	...	...	...	...
n			CN_n	A_n = ∑ areas corresponding to the same CN_n	$A_{np} = \frac{A_n}{Total\ area}$	$CN_{ip} = CN_n \times A_{np}$

Equation 31. Calculation of the mean CN

$$CN_{avg} = \sum_{i=1}^{n} CN_{ip}$$

Where:

n	=	Total number of classes
CN_{ip}	=	CN weighted by land use

Accordingly, with the calculated for the area, its score is defined, in accordance with the CN range and the table below:

Table 66. Scoring for the Water Infiltration and Run-off Indicator (WIR).

Indicator	Description	CN Range	Score
Water Infiltration and Run-off	Without quantification	N/A	0
	Lower infiltration capacity (e.g. asphalted areas)	CN > 85	1
	Low infiltration capacity	70 < CN ≤ 85	2
	Moderate infiltration capacity	55 < CN ≤ 70	3
	High infiltration capacity	40 < CN ≤ 55	4
	Higher infiltration capacity (e.g. sandy soils with high vegetation cover)	CN < 40	5

It is emphasized that:

- Cartographic products must be presented in an appropriate form to illustrate the scenarios;
- The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.3.3 SUSTAINABLE SOIL MANAGEMENT (SSM)

Initially, soil was defined as the material derived from the decomposition of rocks, composed of mineral and organic particles, water and air, which supports plant life. However, soil is more than that: it is a complex and dynamic system that performs several important functions in the ecosystem.[88]. Accordingly, soil performs numerous important functions in the ecosystem, such as:

i. It is the medium for plant growth, acting as physical support for the roots, in the transfer of water and nutrients, and in the maintenance of the microbiological activity of the soil;
ii. It is a regulator of water supply in nature, since it plays an important role in the hydrological cycle, in infiltration and in the maintenance of water quality;
iii. It is an important carbon pool, sequestering atmospheric carbon dioxide (CO_2), reducing the effect of CO_2 in global warming and also acting in the recycling/decomposition of biomass of plant and animal origin;
iv. It is a habitat for living organisms, since soil flora and fauna are fundamental for the maintenance of biodiversity and of the ecosystem services provided by the soil.

This indicator is composed of the set of agricultural practices that aim to conserve the soil and promote sustainable management, with the aim of:

i. Reducing the movement of the soil layers so as to provide less compaction, maintenance of soil structure and reduction of the emission of CO_2 to the atmosphere);
ii. Maintaining the soil vegetation cover (whether living or dead), since covered soil provides the reduction of water and soil losses through erosion, the improvement of soil quality and the conservation of biodiversity;

In this context, obtaining data on the topographic slope of the land is essential for the planning and execution of sustainable soil management practices, allowing the identification of the areas most susceptible to erosion and the adoption of specific conservation measures.

Soil vegetation cover, whether living or dead, represents one of the fundamental principles of sustainable soil management, since it protects the soil against erosion, maintains humidity and promotes the microbiological activity of the soil.

To obtain the **Sustainable Soil Management Indicator**, the methodology requires:

i. Use the Agricultural Cultivation Area as the analysis area of the indicator;

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[88] Doran, J. W., & Parkin, T. B. (1994). **Defining and assessing soil quality. Defining soil quality for a sustainable environment**, 35, 1-21.

ii. Verify and record the number of sustainable soil management practices listed in Table 67 that the EnS Provider applies in its agricultural production;

Table 67. Sustainable practices applied to sustainable soil management in perennial cultivation areas.

Sustainable Soil Management Practices	Description
Contour cultivation	In contour cultivation, the planting rows function as small terraces, reducing the speed of run-off water and, consequently, the erosion of the soil, contributing to the conservation of the soil and water.[89]
Minimum tillage and/or direct planting	Direct planting and minimum tillage systems are characterized principally by not making use of mechanical operations of the soil, maintaining the vegetation cover and promoting the conservation of the soil and water.
Cover cropping or Use of Mulch	The use of cover crops or mulch (straw or plant residues) on the soil surface contributes to the reduction of erosion, the maintenance of humidity and the improvement of the physical, chemical and biological properties of the soil.
Fire Control	Fires, used for the clearance of areas for planting, give rise to various losses to the soil, to biodiversity and to human health, and their control is fundamental for the sustainability of the agricultural production and of the ecosystem services provided by the soil.
Intercropping of more than one plant species	The planting of monocultures, although it presents advantages in production, gives rise to greater loss of biodiversity and of soil quality. The intercropping of more than one plant species contributes to the conservation of the soil, to the maintenance of biodiversity and to the sustainability of the agricultural production.

iii. Obtain the proportion of sustainable soil management practices (SSMP%) applied in the agricultural production, in accordance with the equation below:

Equation 32. Percentage of sustainable practices in soil management carried out in the Agricultural Cultivation Area.

$$SSMP_{\%} = \frac{NP}{NPT} \times 100$$

Where:

$SSMP_{\%}$	=	Percentage of applied agricultural practices
NP	=	Total number of sustainable practices applied by the EnS Provider in soil management
NPT	=	Total number of sustainable practices listed

To obtain the final score relating to the **Sustainable Soil Management Indicator**, relate the proportion of sustainable practices applied to the respective classes of values set out in Table 68.

[89]Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/68394/1/CIRTEC133-tamanho-grafica-2.pdf

Table 68. Scoring for the Sustainable Soil Management Indicator (I_{SSM}).

Indicator	Description	Score
Sustainable soil management	Without quantification	0
	$0 < SSMP_{\%} \leq 20$	1
	$20 < SSMP_{\%} \leq 40$	2
	$40 < SSMP_{\%} \leq 60$	3
	$60 < SSMP_{\%} \leq 80$	4
	$80 < SSMP_{\%} \leq 100$	5

It is emphasized that:

i. Cartographic products and dated and geo-referenced images must be presented in an appropriate form to illustrate the scenarios;
ii. The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.3.4 SUSTAINABLE FERTILISER MANAGEMENT (SFM)

Fertilizers are chemical, mineral or organic compounds that may be added to the soil or applied to the plants, with the aim of supplying the nutrients necessary for plant growth and the maintenance of soil fertility.[90].

With the growth of the world population, estimated at 9.7 billion people by 2050 according to the United Nations[91], agriculture faces increasing pressure to meet the world demand for food, fibers and energy, while seeking to preserve the environment and the ecosystem services provided by the soil.[92], the United Nations agency for agriculture and food, in order to meet that demand, world food production must increase by approximately 70% by 2050, which requires the adoption of sustainable agricultural practices and the efficient use of natural resources.

Accordingly, practices that provide improvements in the maintenance of fertility and reduce the environmental impact of the use of fertilisers are fundamental for the sustainability of agricultural production and for the provision of ecosystem services provided by the soil.

To obtain the **Sustainable Fertilizer Management Indicator**, the methodology provides for:

i. Use the Agricultural Cultivation Area as the analysis area of the indicator;
ii. Verify and record the number of sustainable fertilizer management practices adopted in the Project Area, in accordance with Table 69 that the EnS Provider adopts in its agricultural production;

[90] Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/227063/1/cap14-livro-RecomendacaoCalagemAdubacao-AnaLuciaBorges-AINFO.pdf

[91] Available at: https://population.un.org/wpp/assets/Files/WPP2024_Summary-of-Results.pdf

[92] Available at: https://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf?

Table 69. Sustainable practices adopted in sustainable fertilizer management in perennial cultivation areas.

Sustainable Practices Adopted in Fertiliser Management	Description
Use of organic fertilizers and composting	Organic compounds are the result of the action of numerous organisms that transform organic material into fertilizers, rich in nutrients essential for plant growth and the maintenance of soil fertility.
Green manure	This is the use of nitrogen-fixing plants or plant residues, such as forage, legumes and other species, to improve soil fertility and the maintenance of its physical, chemical and biological properties.
Use of biofertilizers	Biofertilizers are products that include active components or biological agents, such as bacteria and fungi, which promote plant growth and the maintenance of soil fertility, reducing the need for chemical fertilizers.
Foliar fertilization	This consists of the supply of nutrients by the direct assimilation of leaves and fruits, especially in critical stages of the plant cycle, allowing the precise application of nutrients and the reduction of environmental impact.
Stabilized or slow-release fertilizers	Stabilized or slow-release fertilizers reduce greenhouse-gas emissions and allow the efficient use of nutrients by plants, contributing to the sustainability of agricultural production and the maintenance of soil fertility.
Monitoring of soil fertility	Regular monitoring of nutrient levels in the soil for precise fertilizer application, based on the specific needs of the plants and the characteristics of the soil.
Precision fertilization	Precise application of fertilizers based on the specific needs of the plants and the characteristics of the soil, using technologies such as precision agriculture.
Fertigation	Technique that combines irrigation and fertilization, optimizing the use of fertilizers by directly applying the nutrients through the irrigation water, allowing the precise application and the reduction of environmental impact.
Use of nitrogen sources alternative to urea	The use of nitrogen sources alternative to urea, such as ammonium nitrate, calcium nitrate and other forms of nitrogen, may contribute to the reduction of greenhouse-gas emissions and to the efficient use of nitrogen by the plants.[93]. The alternative sources offer greater stability and better efficiency of use by the plants, contributing to the sustainability of agricultural production and to the maintenance of soil fertility.
Sustainable Phosphate Fertilization	The use of reactive natural phosphate-based fertilizers offers a gradual release of nutrients, allowing the precise application and the reduction of environmental impact.[94]. This reduces the need for frequent applications, optimizing agricultural management. From an environmental standpoint, it[95] minimizes the risks of contamination of water bodies, whether by surface run-off or infiltration, contributing to the sustainability of agricultural

[93] Available from: https://www.npct.com.br/publication/IASite.nsf/0/45A2A67BDAE04917032586A8006549F1/$FILE/NPCT-IA-N-09.pdf

[94] Natural Phosphates in System Fertilisation, 2008.

[95] The effect of phosphates with different solubilities on the macronutrient content of maize crops over two growing seasons, 2007

Sustainable Practices Adopted in Fertiliser Management	Description
	production and to the maintenance of soil fertility.[96], which entails lower energy consumption in its production and presents a lower carbon footprint when compared to conventional fertilizers.[97].

iii. Obtain the proportion of sustainable fertilizer management practices (SFMP%) applied in fertilizer management in the Agricultural Cultivation Area, in accordance with the equation below:

Equation 33. Percentage of sustainable practices in fertilizer management adopted in the Agricultural Cultivation Area.

$$SFMP_{\%} = \frac{NP}{N} \times 100$$

Where:

$SFMP_{\%}$	=	Percentage of agricultural practices adopted in fertilizer management
NP	=	Total number of sustainable practices applied by the EnS Provider in fertiliser management
N	=	Total number of sustainable practices listed

To obtain the final score relating to the Sustainable Fertilizer Management Indicator, relate the proportion of sustainable practices applied to the respective classes of values set out in Table 70.

Table 70. Value classes and scoring for the Sustainable Fertilizer Management Indicator.

Indicator	Description	Score
Sustainable Fertiliser Management	Without quantification	0
	$0 < SFMP_{\%} \leq 20$	1
	$20 < SFMP_{\%} \leq 40$	2
	$40 < SFMP_{\%} \leq 60$	3
	$60 < SFMP_{\%} \leq 80$	4
	$80 < SFMP_{\%} \leq 100$	5

It is emphasized that:

i. Cartographic products must be presented in an appropriate form to illustrate the scenarios;
ii. The entire method of obtaining the indicator must be described in a clear and verifiable manner.

5.4 PROJECT CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT

In order to contribute systematically to the achievement of sustainable development, this Methodology seeks to align the PSA projects with the 17 Sustainable Development

[96] The use of natural phosphate in the cultivation of rice, soya beans and maize under no-till farming, 2005.
[97] The use of natural phosphate in the cultivation of rice, soya beans and maize using direct-drilling methods, 2005.

Goals (SDGs) of the United Nations 2030 Agenda, which set the global guidelines for the promotion of sustainable development at the economic, social and environmental levels.[98].

According to Giuliana Kauark, sustainable development consists of the following: "Based on pillars such as social inclusion, environmental sustainability, economic development and good governance, the 2030 Agenda aims to promote an integrated and systemic response to the global challenges of the 21st century, with the aim of ensuring the well-being of present and future generations."[99]

This concept converges with the ideas of Amartya Sen, who does not link the conception of sustainable development solely to the economic dimension, but to the expansion of the real freedoms that people enjoy, through the opportunities for participation and development available to them.[100]

In this perspective, the achievement of sustainable development is conditional upon the opportunity for effective participation of people in the processes of decision-making and development, as well as the adoption of sustainable practices that promote social inclusion and the conservation of ecosystem services.[101]

It is in this scenario that, in the 2000s, the UN proposed the Millennium Development Goals (MDGs)[102], a commitment signed by 189 countries. As these were not achieved by 2012, that Organization launched, in 2015, the 2030 Agenda, which includes the 17 Sustainable Development Goals (SDGs), broader and more ambitious than the MDGs.

Thus, according to the UN, the 2030 Agenda: "is a collection of targets, guiding principles and perspectives that seek to promote sustainable development at the economic, social and environmental levels, with the aim of ensuring the well-being of present and future generations, through the promotion of social inclusion, the conservation of ecosystems and the adoption of sustainable practices."[103]

The purpose of the 2030 Agenda and its goals fully converges with the updates of this Methodology, which seeks to align the PSA projects with the SDGs and to promote sustainable development at the economic, social and environmental levels.

The SDGs, adopted by all the Member States of the United Nations in 2015, consist of 17 objectives and 169 targets, which cover economic, social and environmental aspects

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98 Available at Objetivos de Desenvolvimento Sustentável | As Nações Unidas no Brasil.

99 KAUARK, Giuliana. Cultural diversity and sustainable development. Chapter 3: "Diversity, culture and development". p. 47. [e-book] / edited by José Márcio Barros. -- 1st ed. -- Belo Horizonte, MG: Observatory of Cultural Diversity, 2020 available at: Diversidade-Cultural-e-Desenvolvimento-Sustentavel_.pdf

100 SEN, Amartya. Development as Freedom. São Paulo: Companhia das Letras, 2010.

101 LISBON, Teresa Kleba, LUSA, Mailiz Garibotti. Sustainable Development from a Gender Perspective – Brazil, Mexico and Cuba: Women as Key Players in Rural Areas. Revista Estudos Feministas. Florianópolis, Brazil, 2010.

102 MDGs BRAZIL. The Millennium Development Goals, 2000. Available at http://www.odmbrasil.gov.br/os-objetivos-de-desenvolvimento-do-milenio.http://www.odmbrasil.gov.br/os-objetivos-de-desenvolvimento-do-milenio Accessed on 28 Jan. 2023.

103 AGENDA 2030 (Brazil). The 17 Sustainable Development Goals. [S. L.], 2021. Available at: https://brasil.un.org/pt-br/sdgs/5 . Accessed 14 Feb 2024.

of sustainable development, with the aim of ensuring the well-being of present and future generations. The figure below presents the 17 SDGs:

Figure 5. Sustainable Development Goals.

Source: Taken from the United Nations.

To assess the performance of compliance with the SDGs in PSA projects under this Methodology, the developer must present a critical analysis of the contribution of the project to each of the 17 SDGs, considering the targets applicable to the project's context and the indicators adopted in the Methodology.

It should be emphasized that the EnS Provider or producer is not required to comply with all 17 SDGs, but to present a critical analysis of the contribution of the project to each of them, considering the targets applicable to the project's context and the indicators adopted in the Methodology. See Annex III. Comparison of SDG targets with project indicators and recommended supporting documentation for demonstrating compliance with each target, where the targets relating to the indicators that make up this Methodology are listed.

To obtain the **SDG Factor**, the application of the following parameters is recommended:

i. Identify the number of SDGs proposed by the developer and the number of SDGs effectively met by the project, in accordance with the critical analysis of the contribution of the project to each of the 17 SDGs;
ii. Apply weights of the SDGs defined by the developer. The definition of the weights for each SDG must take into account the relevance of the SDG for the project's context and the indicators adopted in the Methodology (see Annex IV. Sustainable Development Goal weights for application in);
iii. Calculate the SDG compliance indicator, in accordance with the equation presented below;
iv. Obtain the SDG Factor in accordance with the classification in performance categories (low, medium and high), as set out in the table below.

It is emphasized that

i. The proportion between proposed and achieved SDGs must be rigorously verified, to ensure the accuracy and reliability of the SDG compliance indicator;

ii. The score assigned must be accompanied by an objective description of the actions implemented for compliance with the SDGs, in accordance with the guidelines of Annex III. Comparison of SDG targets with project indicators and recommended supporting documentation for demonstrating compliance with each target.;
iii. Transparency and traceability of the data used must be ensured, with presentation of the supporting documentation and the verifiable records, in accordance with Annex III. Comparison of SDG targets with project indicators and recommended supporting documentation for demonstrating compliance with each target.

The SDG Factor will be obtained by means of the steps listed below:

To measure compliance with the SDGs and incorporate their weights on the basis of the priority of each SDG for the project's context, the equation below is used The formula is:

Equation 34. Calculation of the SDG compliance indicator.

$$Indicator\ of\ SDG = \frac{\sum_{i=1}^{n}(SDG_i achieved \times P_i)}{\sum_{i=1}^{n}(SDG_i proposed \times P_i)}$$

Where:

n	=	Total number of proposed SDGs
P_i	=	Weight assigned to the SDG
$SDG\ achieved$	=	Where the SDG has been complied with, it is counted as 1 (yes); otherwise, it is 0 (no).

The SDG compliance indicator ranges from 0 to 100, determining the performance of the EnS Provider or producer:

- Low performance: Index < 50
- Medium performance: Index between 50 and 75
- High performance: Index > 75

The SDG Factor is determined in accordance with the SDG compliance indicator, as set out in the table below, which will be applied in the calculation of the Tradable C+ Cultivation (see item 5.8.1), with the aim of taking into account the efforts of the environmental services provider in seeking to achieve sustainable development:

Table 71. Determination of the SDG Factor.

SDG compliance indicator	SDG Factor
<50	-2%
≥50 and ≤70	0%
>70	+2%

5.5 ECOSYSTEM INDICATORS MATRIX

Once the Ecosystem Indicators have been measured in the previous items, the Methodology provides for the aggregation of those indicators into a single Matrix, which will be used for the calculation of the conversion of the carbon stock into C+ (see item 5.7.2). The Ecosystem Indicators Matrix is an integrated tool that allows the assessment of the overall performance of the project in terms of the provision of ecosystem services, taking into account the scores and weights of each indicator.

Table 72. Indicators, description, scores and weights.

Indicator	Measurement Method	Score variation	Weight
Stored Carbon (I_{StC})	Carbon stock in tCO_2e	N/A	N/A
Sequestered Carbon (I_{SeC})	Sequestered carbon in tCO_2e	N/A	N/A
Native Vegetation Cover (I_{NVC})	Percentage of native vegetation cover in the Project Area	1 to 5	1
Structural Connectivity (I_{Con})	Variation in landscape connectivity with and without the Project Area.	1 to 5	1
Proportionality (I_{Prop})	Mean fragment size in the Project Area versus Area of Influence.	1 to 5	1
Matrix Permeability (I_{MP})	Assesses the ability of use and movement of fauna species in the land-use matrix, according to the surrounding landscape.	0 to 30	1
APP Conservation (I_{APPC})	Effective APP area versus mandatory APP area.	1 to 5	1
Spring density (I_{SD})	Mean spring density in the Project Areas versus Area of Influence.	1 to 5	1
Biodiversity (I_{BFL})	Vegetation status and disturbance potential	Forest Formations (FF): 12 to 60; Savanna Formations (FS): 10 to 50	2
Biodiversity (I_{BFN})	Fauna status	3 to 15	1
Sociocultural Impact (I_{SCI})	Status of the sociocultural influence of the Project Area.	6 to 30	1
Total		**FF: 26 to 160; FS: 24 to 150.**	**10**

Thereafter, the developer must normalize the score of the Project Area by bringing together all the scoring ranges and dividing by the maximum possible value (see item 5.7.2).

As mentioned previously, the PSA project must necessarily take into account the mandatory Ecosystem Indicators. Eight are predefined, with the I_{StC} and the I_{SeC} not entering into the Ecosystem Indicators Matrix. Thus, the six predefined for the Matrix are: I_{NVC}, I_{MP}, I_{APPC}, $I_{BFL,}$ $I_{BFN,}$ I_{SCI} (see specific items for limitations).

The Ecosystem Indicators Matrix may be calculated on the basis of Equation 35. The sum of the selected indicators will yield a score that will be normalized to a scale from 0 to 100%, which will be used in the calculation of the conversion of carbon stock into C+.

Equation 35. Ecosystem Indicators Matrix.

$$Ecosystem\ Indicators\ Matrix\ (\%) = 100\ x\ \frac{I_{NVC} + I_{Con} + I_{Prop} + I_{MP} + I_{APPC} + I_{SD} + 2\ x\ I_{BFL} + I_{BFN} + I_{SCI}}{1 + n}$$

Where:

Table 73. Parameters of the Ecosystem Indicators Matrix equation.

Indicator	Acronym		Scoring Parameter
Native Vegetation Cover*	I_{NVC}	=	$\frac{\text{NVC Score}}{5}$
Structural Connectivity	I_{Con}	=	$\frac{\text{Connectivity Score}}{5}$
Proportionality	I_{Prop}	=	$\frac{\text{Proportionality Score}}{5}$
Matrix Permeability*	I_{MP}	=	$\frac{\text{MP Score}}{30}$
APP Conservation*	I_{APPC}	=	$\frac{\text{APP Conservation Score}}{5}$
Spring Density	I_{SD}	=	$\frac{\text{Spring Density Score}}{5}$
Biodiversity – flora*	I_{BFL}	=	FF: $\frac{\text{Biodiversity Score}}{60}$
			FS: $\frac{\text{Biodiversity Score}}{50}$
Biodiversity – fauna*	I_{BFN}	=	$\frac{\text{Biodiversity Score}}{15}$
Sociocultural Impact*	I_{SCI}	=	$\frac{\text{Sociocultural Score}}{30}$
n	n	=	Number of EcS indicators quantified

* mandatory indicator.

[1] May only be used together with I_{CVN} if the Project Area is located in areas where the Legal Reserve is at least 35%.

It is emphasized that:

- As mentioned in item 5.2.1.1Stored Carbon, Stored Carbon will be the benchmark indicator for the other Ecosystem Indicators;
- With the evolution of the Methodology, new indicators may be added and their weights adjusted, in accordance with the specific conditions of the Project Area and the ecosystem services provided.

5.6 AGRICULTURAL PRACTICES MATRIX

Once the Agricultural Practices Indicators have been assessed in the previous items, the Methodology provides for the aggregation of those indicators into a single Matrix, which will be used for the calculation of the conversion of carbon sequestration into C+ (see item 5.8.1). The Agricultural Practices Matrix is an integrated tool that allows the assessment of the overall performance of the project in terms of good agricultural practices, taking into account the scores and weights of each indicator.

Table 74. Indicators, description, scores and weights.

Indicator	Measurement Method	Score variation	Weight
Agrochemicals Scenario 1 (I_{AC1})	Score assigned to data-analysis scenarios as regards the agrochemicals used in agricultural production.	0 to 1	1
Agrochemicals Scenario 2 (I_{AC2})	Score assigned to data-analysis scenarios as regards the agrochemicals used in agricultural production.	0 to 1	1
Agrochemicals Scenario 3 (I_{AC3})	Score assigned to data-analysis scenarios as regards the agrochemicals used in agricultural production.	0 to 1	1
Impact of Arable Areas on Water Quality (I_{IAAWQ})	Analysis of the impact of arable areas close to water courses, identifying the impact of arable areas on water quality.	0 to 5	1
Water Sustainability in Agriculture (I_{WSA})	Efficiency of the agricultural practices adopted in preventing each pollutant from reaching water bodies, on the basis of the classification of the agricultural practices.	0 to 5	1
Water Use Efficiency (I_{WUE})	Scoring of water-use efficiency through the different irrigation practices.	0 to 5	1
Water Infiltration and Run-off (I_{WIR})	The scoring takes into account the type, use and quality of the soil, assessing the level of infiltration and surface run-off.	0 to 5	1
Sustainable Soil Management (I_{SSM})	Quantification of sustainable soil management practices applied.	0 to 5	1
Sustainable Fertiliser Management (I_{SFM})	Quantification of sustainable fertiliser management practices applied.	0 to 5	1
Total		**0 to 31**	**7**

Thereafter, the developer must normalize the score of each of the predefined indicators, summing up the scoring ranges and dividing by the maximum possible value, to obtain the score of the Agricultural Practices Matrix (see Table 75), which will be used for the calculation of the conversion into Carbon (see item 5.8.1).

As mentioned previously, the PSA project must necessarily take into account, at a minimum, **five** Agricultural Practices Indicators, with four being predefined. Thus, the four predefined are: I_{AC}, I_{WUE}, I_{SSM}, I_{SFM}, and, at a minimum, one more must be chosen (see specific items for limitations).

The Agricultural Practices Matrix may be calculated based on Equation 36. The sum of the selected indicators will yield a score that will be normalized to a scale from 0 to 100%, which will be used in the calculation of the conversion of carbon sequestration into C+.

Equation 36. Agricultural Practices Indicators Matrix.

$$Agricultural\ Practices\ Indicators\ Matrix(\%) = 100 \times \frac{I_{AC} + I_{IAAWQ} + I_{WSA} + I_{WUE} + I_{WIR} + I_{SSM} + I_{SFM}}{n}$$

Where:

Table 75. Parameters of the Agricultural Practices Indicators Matrix equation.

Indicator	Acronym		Scoring Parameter
Agrochemicals Scenario 1*	(I_{AC1})	=	I_{AC1}
Agrochemicals Scenario 2[1]	(I_{AC2})	=	I_{AC2}
Agrochemicals Scenario 3[1]	(I_{AC3})	=	I_{AC3}
Impact of Arable Areas on Water Quality	(I_{IAAWQ})	=	$\frac{I_{IAAWQ\ Score}}{5}$
Water Sustainability in Agriculture	(I_{WSA})	=	$\frac{I_{WSA\ Score}}{5}$
Water Use Efficiency*	(I_{WUE})	=	$\frac{I_{WUE\ Score}}{5}$
Water Infiltration and Run-off	(I_{WIR})	=	$\frac{I_{WIR\ Score}}{5}$
Sustainable Soil Management*	(I_{SSM})	=	$\frac{I_{SSM\ Score}}{5}$
Sustainable Fertiliser Management*	(I_{SFM})	=	$\frac{I_{SFM\ Score}}{5}$
n	n	=	Number of Indicators of agricultural practices quantified

* mandatory indicator.
[1] Only one of the agrochemical scenarios may be used for the calculation of the I_{AC}.

It is emphasized that:

- As mentioned in item 5.2.1.2, Sequestered Carbon will be the benchmark indicator for the other Agricultural Practices Indicators;
- With the evolution of the Methodology, new indicators may be added and their weights adjusted, in accordance with the specific conditions of the Project Area and the ecosystem services provided.

5.7 C+ NATIVE CALCULATION

5.7.1 TOTAL ACCUMULATED STOCK (NATIVE)

The Total Accumulated Stock represents the carbon stock in the WNVA projected for the last year of the Valuation Period of the project, which will be used as a basis for the calculation of the Gross C+ (Native). The Total Accumulated Stock is estimated on the basis of the total tree carbon stock in the WNVA in the last year of the Valuation Period of the project, in accordance with the equation below:

Equation 37. Calculation of the Total Accumulated Stock.

$$Total\ accumulated\ stock\ =\ C_{tree,\ tf}$$

Where:

Table 76. Parameters for obtaining the Total Accumulated Stock.

Total Accumulated Stock	=	Total amount of carbon stocked in the last year of the Valuation Period of the project that may be converted into Gross C+ (Native); tCO_2e
Ctree, tf	=	Total tree carbon stock in the Woody Native Vegetation Area in the last year of the Valuation Period of the project; $t\ CO_2e$

5.7.2 CONVERSION OF STOCK INTO GROSS C+ (NATIVE)

The Methodology considers that an ecosystem fully occupied by native vegetation cover is in its maximum potential of carbon stock and provision of ecosystem services. However, the conservation of ecosystems and the adoption of good agricultural practices contribute to the maintenance and enhancement of the carbon stock in the WNVA, which is fundamental for the mitigation of climate change and for the conservation of biodiversity.

Since carbon storage and sequestration is a paramount EcS as regards the mitigation of climate change, the conservation of native vegetation and the adoption of sustainable agricultural practices are fundamental for the maintenance and enhancement of the carbon stock in the WNVA, which is the basis for the calculation of the Gross C+ (Native).

In turn, the valuation and remuneration of the EnS of implementation of sustainable agricultural practices is conditional on the demonstration of the provision of ecosystem services and on the maintenance and enhancement of the carbon stock in the WNVA.

In view of this, the conservationist and sustainable production efforts are responsible for the maintenance and enhancement of the carbon stock in the WNVA, which is the basis for the calculation of the Gross C+ (Native).

A factor of forest degradation has been considered, comparing two future projections: the optimistic scenario and the trend scenario for 2100 in relation to the impacts of climate change. That is to say, the difference between the optimistic and the trend scenarios for 2100 as regards the forest cover in Brazil, which will be used as a basis for the calculation of the forest degradation factor.

For the definition of the degradation factor, the *Representative Concentration Pathways (RCPs)* – a set of scenarios that cover ranges of values of radiative forcing (differences between the incoming and outgoing radiation in the atmosphere) for the year 2100 – have been taken into account.[104]. According to Popp et al, 2017[105], the vegetation cover in the optimistic scenario (RCP 2.6) would be 600 million hectares greater than in the trend scenario (RCP 8.5), which represents a difference of 15% of the world's forest cover in 2100.[106]. That is to say, if nothing is done, there will be 15% less forest cover in the world than in the optimistic scenario, which will be used as a basis for the calculation of the forest degradation factor.

In this context, with a view to taking into account the contribution of PSA projects to the optimistic scenario, the degradation factor of 10% has been adopted for the calculation of the Gross C+ (Native), in accordance with the equation below:

Equation 38 . Conversion of Stock into Gross C+ (Native).

[104] Available at: https://link.springer.com/article/10.1007/s10584-011-0148-z

[105] Available at: https://www.sciencedirect.com/science/article/pii/S0959378016303399

[106] Available at: https://www.fao.org/3/ca8642en/ca8642en.pdf

$$C+_{gross,\ native} = \frac{Total\ Accumulated\ Stock}{100} \times EI\ Matrix_{\%} \times Proj.\ Degradation\ CC_{\%}$$

Where:

Table 77. Parameters for the Carbon conversion equation.

$C+_{gross,\ native}$	=	Total amount of C+ generated annually by the project during its period that may be converted into Gross C+ (Native); tCO_2e
$Total\ Accumulated\ Stock$	=	Total amount of carbon stocked in the last year of the Valuation Period of the project that may be converted into Gross C+ (Native); tCO_2e. Value estimated in item 2.8.1.
$EI\ Matrix_{\%}$	=	Sum of the score determined in item 5.5 of the Ecosystem Indicators Matrix divided by the maximum score
$Proj.\ Degradation\ CC_{\%}$	=	Projected degradation by climate change - Estimated difference of forest cover between realistic and trend scenarios for 2100.

Accordingly, the construction of the concept of additionality in the context of the PSA Carbon Agro Perene is founded, which is fundamental for the assessment of the contribution of the project to the mitigation of climate change and the conservation of biodiversity.

The document "Complement – Foundation of the C+ Calculation" presents the technical and scientific content that underpins the calculation of the Gross C+ (Native), in accordance with the Equation 38 above.

From the $C+_{Gross,\ native}$, the credits that must be allocated to the Safety Reserve are quantified, and those that will be available for trading, in accordance with the items below.

5.7.3 SAFETY RESERVE (NATIVE)

This Methodology establishes a Safety Reserve for the application of the PSA project, which aims to ensure the integrity of the credits generated and the traceability of the EnS provided.

The Safety Reserve corresponds to a percentage of $C+_{Gross,\ native}$ accounted for in the Woody Native Vegetation Area that may not be traded at the time of its issuance, being accumulated in each monitored period to ensure compensation for any project reversals.

The percentage Safety Reserve, for this Methodology, will follow a pattern of incremental increase, in accordance with the duration of the project, as set out in the equation below:

Equation 39. Calculation of the percentage required for the Safety Reserve (%).

$$\text{Safety Margin (\%)} = 10 + \left(\frac{(100 - \text{Valuation Period})}{3}\right)$$

Where:

Table 78. Parameters of the Safety Reserve (%) calculation equation.

$Safety\ Margin\ (\%)$	=	Percentage of C+ $_{Gross,\ native}$ that must be set aside as safety reserve; %
$Valuation\ Period$	=	Duration of the project; years

A different percentage for the Safety Reserve may be applied, provided that it is justified in the item 5.14 Methodological adaptations accepted and approved by the developer of the Methodology.

Once the percentage of Safety Reserve for the project is known, the amount of C+ to be set aside for the safety reserve account of the project must be quantified, in accordance with the equation below:

Equation 40. Composition of the Safety Reserve.

$$C+_{Safety\ Reserve,native} = C+_{Gross,\ native} \times Safety\ Reserve\ (\%)$$

Where:

Table 79. Parameters associated with the composition of the Safety Reserve.

$C+_{Safety\ Reserve,native}$	=	Total amount of C+ set aside annually for the safety reserve account of the project; tCO_2e
$C+_{Gross,\ native}$	=	Total amount of C+ generated annually by the project during its period; tCO_2e
$Safety\ Reserve\ (\%)$	=	Percentage of C+ $_{Gross,\ native}$ that must be set aside as safety reserve; %

This method for calculating the Safety Reserve applies exclusively to projects that ensure a minimum 40-year provision of Ecosystem Services (EcS) and maintenance of Environmental Services (EnS). If this permanence is altered due to contractual conditions, specific discount mechanisms must be established to reflect this modification..

5.7.4 TRADABLE C+ (NATIVE)

For the calculation of the C+ $_{Tradable,\ native}$, the amount of credits set aside for the safety reserve must be subtracted from the credits generated annually by the project during its Valuation Period, in accordance with the equation below:

Equation 41. Calculation of Tradable C+ (Native).

$$C+_{Tradable,\ native} = C+_{Gross,\ native} - C+_{Safety\ Reserve,\ native}$$

Where:

Table 80. Parameters of the Tradable Carbon calculation equation – Stored Carbon.

$C+_{Tradable,\ native}$	=	Total amount of C+ originating from the Woody Native Vegetation Area, available for trading in a given monitored period; tCO_2e

$C +_{Gross,\ native}$	=	Total amount of C+ generated annually by the project during its Valuation Period; tCO_2e
C+ safety reserve, native	=	Total amount of C+ set aside annually for the safety reserve account of the project; tCO_2e

Through the formula presented above, the quantity of $C+_{\text{tradable, native}}$ (tCO_2e) that may be traded per year is obtained, and which is directly related to the environmental performance of the project.

It is important to emphasize that shorter projects will only be able to trade a fraction of the credits equivalent to the project's duration, and not the entirety of the credits. A 40-year project will only be able to commercialize 40% of its $C+_{\text{tradable, native}}$ stock over its entire duration.

5.8 C+ CULTIVATION CALCULATION

5.8.1 CONVERSION OF STOCK INTO GROSS C+ (CULTIVATION)

The credits originating from the Agricultural Cultivation Area are obtained from the Sequestered Carbon (item 5.2.1.2.2), the score obtained by the Agricultural Practices Matrix (item 5.6) and the performance of the project in relation to the Sustainable Development Goals (item 5.4).

Unlike what is done for the formation of the $C+_{\text{Gross, native}}$, the degradation factor (Proj. Degradation.CC%) must not be applied in the conversion of the credits of the Agricultural Cultivation Area. The calculation of $C+_{\text{Gross, cultivation}}$ is given by the following equation:

Equation 42. Equation for converting sequestration into C+ Cultivation.

$$C +_{Gross,cultivation} = \frac{Sequestered\ Carbon}{Valuation\ Period}\ x\ (API\ Matrix\ [\%] + SDG\ Factor[\%])$$

Where:

Table 81. Parameters for the Carbon conversion equation.

$C +_{Gross,cultivation}$	=	Number of carbon credits generated annually by carbon sequestration in the Agricultural Cultivation Area during its period; tCO_2e
$Sequestered\ Carbon$	=	Total carbon sequestration in the Agricultural Cultivation Area during the valuation period; tCO_2e
$API\ Matrix\ [\%]$	=	Sum of the score determined in item 5.6 of the Agricultural Practices Indicators Matrix divided by the maximum score
$SDG\ Factor[\%]$	=	Bonus or discount generated by the performance of the project in relation to the Sustainable Development Goals (SDG), in accordance with item 5.4.

It is emphasized that the sum of the API Matrix with the SDG Factor may not exceed the value of 100%.

It is reiterated that, in this way, the construction of the concept of additionality in the context of the PSA Carbon Agro Perene is founded, considering the contribution of the project to the mitigation of climate change through the carbon removal rates.

The document “Complement – Foundation of the C+ Calculation” presents the technical and scientific content that underpins the calculation of the Gross C+ (Cultivation), in accordance with the Equation 42 above.

From the $C+_{\text{Gross, cultivation}}$, the credits that must be allocated to the Safety Reserve associated with the Agricultural Cultivation Area are quantified, and those that will be available for trading, in accordance with the items below.

5.8.2 SAFETY RESERVE (CULTIVATION)

The Safety Reserve percentage for the credits originating from the Agricultural Cultivation Area will follow a pattern of incremental increase, in accordance with the duration of the project, as set out in the equation below:

Equation 43. Calculation of the percentage required for the Safety Reserve (%).

$$\text{Safety Margin (\%)} = 10 + \left(\frac{(100 - Valuation\ Period)}{3}\right)$$

Where:

Table 82. Parameters of the Safety Reserve (%) calculation equation.

$Safety\ Margin\ (\%)$	=	Percentage of $C+_{\text{Gross, cultivation}}$ that must be set aside as safety reserve; %
$Valuation\ Period$	=	Duration of the project; years

A different percentage for the Safety Reserve may be applied, provided that it is justified in the item 5.14 and accepted and approved by the developer of the Methodology.

Once the Safety Reserve percentage for the project is known, the amount of C+ to be set aside for the safety reserve account of the project must be quantified, in accordance with the equation below:

Equation 44. Composition of the Safety Reserve.

$$C+_{Safety\ reserve,cultivation} = C+_{Gross,\ cultivation} \times Safety\ Reserve\ (\%)$$

Where:

Table 83. Parameters associated with the composition of the Safety Reserve.

$C+_{Safety\ reserve,cultivation}$	=	Total amount of C+ set aside annually for the safety reserve account of the project; tCO_2e
$C+_{Gross,\ cultivation}$	=	Total amount of C+ generated annually by the project during its period; tCO_2e
$Safety\ Reserve\ (\%)$	=	Percentage of $C+_{\text{Gross, cultivation}}$ that must be set aside as safety reserve; %

This method for calculating the Safety Reserve applies exclusively to projects that ensure a minimum 40-year provision of Ecosystem Services (EcS) and maintenance of

Environmental Services (EnS). If this permanence is altered due to contractual conditions, specific discount mechanisms must be established to reflect this modification.

5.8.3 TRADABLE C+ (CULTIVATION)

For the calculation of the C+ $_{\text{Tradable, native}}$, the amount of credits set aside for the safety reserve must be subtracted from the credits generated annually by the project during its Valuation Period, in accordance with the equation below:

Equation 45. Calculation of Tradable C+ (Cultivation).

$$C+_{Tradable,\ cultivation} = C+_{Gross,\ cultivation} - C+_{Safety\ Reserve,cultivation}$$

Where:

Table 84. Parameters of the Tradable Carbon calculation equation – Sequestered Carbon.

$C+_{Tradable,\ cultivation}$	=	Total amount of C+ originating from the Agricultural Cultivation Area, available for trading in a given monitored period; tCO_2e
$C+_{Gross,\ cultivation}$	=	Total amount of C+ generated annually by the project during its Valuation Period; tCO_2e
$C+_{Safety\ Reserve,cultivation}$	=	Total amount of C+ set aside annually for the safety reserve account of the project; tCO_2e

5.9 FINAL C+ CALCULATION

The last calculation of final tradable C+ for a given monitoring period, or for the project as a whole, is obtained by the sum of the Tradable C+ (Native) and the Tradable C+ (Cultivation), in accordance with the equation below:

Equation 46. Equation for calculating final C+.

$$\boldsymbol{C+} = C+_{Tradable,\ native} + C+_{Tradable,\ cultivation}$$

Where:

Table 85. Parameters for the Carbon conversion equation.

$\boldsymbol{C+}$	=	Number of carbon credits generated annually by the project during its period; tCO_2e
$C+_{Tradable,\ native}$	=	Number of carbon credits generated annually in the Native Vegetation Area by the project; tCO_2e
$C+_{Tradable,\ cultivation}$	=	Number of carbon credits generated annually in the Agricultural Cultivation Area by the project; tCO_2e

5.10 REVERSALS

The assessment of reversals consists of quantifying and reporting CO_2 emissions that were stored in the carbon pools included in the project and monitored over time, which may have been released as a result of environmental disturbances or of removal of project areas.

Reversals take into account causes originating from environmental disturbances in the Woody Native Vegetation Area (WNVA) and in the Agricultural Cultivation Area (ACA), such as deforestation, fires, pests and diseases, erosion, heatwaves, droughts, windstorms, hail, among others. Furthermore, the removal of project areas within the WNVA and ACA is considered a reversal.

In this item, the disturbances identified in the Project Area and their respective mitigation measures must be listed and described, as applicable, in accordance with the guidelines below:

i. Observe and monitor the vectors of deforestation, fire and other vectors of disturbance of the native vegetation and of the Agricultural Cultivation Area, on the basis of official data sources and of secondary data of recognized quality;
ii. Present a description of the measures adopted to mitigate potential losses, where existing, as well as the actions of monitoring and verification of the reversals occurred;
iii. Present cartographic products that indicate the location and characteristics of the disturbance scenario, where applicable, as well as the records of the values monitored in the period assessed.
iv. Where there is (if any) illegal timber extraction in the Project Area, and the accumulated extraction gives rise to losses of carbon stock, the reversal must be quantified and reported in accordance with the guidelines below:

Where there is any reversal, the Safety Reserve account set up for the project must be accessed, in accordance with the specific conditions of the project and the reversals occurred.

5.11 PROPERTY SELECTION CRITERIA

The eligibility criteria of the Methodology for the selection of properties as candidates to participate in a PSA project under the PSA Carbon Agro Perene are as follows:

i. Existence of conserved native vegetation, in accordance with the biome of insertion. Properties with conserved native vegetation, in accordance with the biome of insertion, are eligible for the application of the Methodology;
ii. Properties with perennial crop cultivation to be implemented, under implementation or already implemented, in accordance with the specific conditions of the Project Area;
iii. Meet the eligibility criteria for cultivation area in accordance with items 5.11.1 and 5.13.1.2.
iv. Properties with proof of the legal regularity of the cultivation, in accordance with the licenses and authorizations applicable to the Brazilian agricultural legislation;
v. Proof of completed registration on the ECCON Data platform;
vi. Absence of overlap with Integral Protection Conservation Units, in accordance with Brazilian legislation[107];
vii. Absence of overlap with lands of traditional populations, such as indigenous and quilombola, in accordance with Brazilian legislation;

[107] As provided for in Law 14.119/2021, in Article 9, item III, Private Natural Heritage Reserves (“RPPNs”) are eligible for environmental services on private land, as well as areas within buffer zones and ecological corridors covered by native vegetation, pursuant to Law No. 9,985 of 18 July 2000.

viii. For Woody Native Vegetation Areas, the native vegetation must be conserved, with a history of vegetation cover of at least 10 years prior to the date of adherence to the PSA Carbon Agro Perene program.

ix. Regularity of documentation in accordance with items 5.11.1 and 5.13.1.2.

x. Provision of a declaration from the EnS Provider or producer indicating that there is no overlap with other PSA projects or carbon projects in the Project Area, in order to avoid the risk of double counting.

xi. Verification of the existence of PSA projects registered in the National Registry of Payment for Environmental Services (CNPSA), in accordance with Brazilian legislation.

Accordingly, it is important to highlight that this Methodology may be applicable in territories collectively owned by traditional populations, such as indigenous and quilombola, provided that the specific conditions of the Project Area and the legal requirements applicable are observed.

5.11.1 ELIGIBILITY CRITERIA

The eligibility of the properties already selected for the implementation of the Project under this Methodology will be verified in accordance with the documentary and location criteria set out in the table below:

Table 86. Guidance on eligibility criteria (documentary and location).

Documentary Criteria	
Documents of the holder	Justify the applicability of this document If a natural person, copy of the CPF/RG/CNH. If a legal person, extract from the CNPJ, copy of the articles of association and other documents relevant to the identification of the holder. Characterize them in item 5.13.1.2
CAR	Justify the applicability of this document. Present an extract of the CAR containing the name of the property and of the owner, as well as the geographical coordinates and the area of the property. Characterize them in item 5.13.1.2.
Property title record (matrícula) or Term of Possession	Justify the applicability of this document. Present the property title record issued within the last 90 days. Where there is no property title record, obtain a transcription of possession, in accordance with Brazilian legislation. Characterize them in item 5.13.1.2.
CCIR	Justify the applicability of this document. Make available updated CCIR. Characterize them in item 5.13.1.2
Certificate of civil proceedings[108]	Justify the applicability of this document Make available the updated document relating to the owner(s) or holder(s). Characterize them in item 5.13.1.2

[108] This certificate confirms that there are no civil proceedings pending against a person or company. It must be issued by the High Court in the county where the property is located.

Certificate of criminal proceedings[109]	Justify the applicability of this updated document relating to the owner(s) or holder(s). Make available the document Characterize them in item 5.13.1.2
Certificate of municipal and state taxes[110]	Justify the applicability of this document Make available the updated document relating to the owner(s) or holder(s). Characterize them in item 5.13.1.2
Federal Revenue Debt Certificate[111]	Justify the applicability of this document Make available the updated document relating to the owner(s) or holder(s). Characterize them in item 5.13.1.2
Labour Proceedings Certificate[112]	Justify the applicability of this document Make available the updated document relating to the owner(s) or holder(s). Characterize them in item 5.13.1.2
Negative certificate of embargo from Ibama[113]	Justify the applicability of this updated document relating to the owner(s) or holder(s). Make available the document Characterize them in item 5.13.1.2
	Location Criteria
Overlap with Protected Areas	List the elements of overlap. The following are mandatory: Cavities and caves Geological sites Archaeological sites Indigenous Territories Quilombola Territories Conservation Units Characterize them in item 5.13.1.2
APP and RL	Base the applicability of APPs and RLs in accordance with Law No. 14,119/2021 Characterize them in item 5.13.1.2
History of vegetation cover in the last 10 years	Base the investigation of vegetation cover over the minimum period of 10 years prior to the start of the Valuation Period. Characterize them in item 5.13.1.2
History of Cultivation	Base the investigation into the cultivation proving that the eligible area is under perennial crop cultivation. Characterize them in item 5.13.1.2

It is emphasized that, among the documentary criteria, the (i) Property title record or Term of Possession and (ii) CAR are mandatory, with the others being required in accordance with the specific conditions of the Project Area.

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[109] This certificate confirms that there are no criminal proceedings pending against a person or company. It must be issued by the High Court of Justice in the county where the property is located.

[110] This certificate confirms that there are no outstanding tax or fiscal debts in the name of an individual or company.

[111] This certificate confirms that there are no outstanding tax liabilities with the Federal Revenue Service in the name of an individual or company. Obtain it via the Federal Revenue Service website.

[112] This certificate confirms that there are no ongoing labour disputes in the name of an individual or company. It must be issued by the Regional Labour Court in the area where the property is located.

[113] The embargo, imposed by IBAMA, is a punitive and preventive measure designed to curb unauthorised deforestation, thereby facilitating the recovery of the ecosystem. The certificate of compliance is important for confirming that vegetation clearance has been carried out in accordance with the regulations.

5.12 ADHERENCE DATE AND VALUATION PERIOD

The Adherence Date corresponds to the date of verification of the commencement of conservation services and the implementation of good agricultural and socio-cultural practices, considered in the PSA project; that is, the date on which the Developer verifies that the environmental conservation services have begun, proving its submission to the Methodology and providing subsidies for the production of reports related to the Methodology, where the conservation or improvement actions of the services and the improvement of agricultural and socio-cultural practices will be described throughout the project period.

The Valuation Period is the period during which the services generated by the project will be measured. The beginning of this period may be retroactive to the signing of the contract, limited to 5% of the Valuation Period, if there is formal and known evidence of activities to interrupt and combat deforestation; to maintain or increase the services and provide environmental services.

It should be noted that retroactivity only applies to actions for the conservation of native vegetation, and not to the implementation of past good agricultural practices. The retroactive count, which begins with reference to the first MR, will be applicable in the measurement of EcS related to carbon stock. In this case, the retroactive date may be considered for the accounting of EcS related to carbon, thus being valid for the average carbon stock count.

In other words, the Valuation Period, which must have a minimum duration of 40 (forty) years and an ideal maximum of 100 (one hundred) years, is the period in which the monitoring of EcS will occur.

5.12.1 PROJECT PERIODS

The PSA project developed under this Methodology has two types of period: (i) the Valuation Period and (ii) the monitoring periods, which must be described and justified in the MCR and MR.

The Valuation Period, as indicated in the item above, is the period during which the EcS generated by the project will be measured.

In turn, the monitoring periods are the periods established by the developer for the monitoring of the EnS provided by the project, which must be described and justified in the MCR and MR.

Once the parameters presented in item 5.12 have been determined, the temporal variables adopted for the PSA project must be described and justified, in accordance with the specific conditions of the Project Area.

Present the temporal information in tabular form, as in the examples below:

Table 87. Example Project Period table.

Dates	Valuation Period	Monitoring Period
Start Date	Start of the environmental service provision proven from	Date established by the developer as the start of the EnS monitoring

Dates	Valuation Period	Monitoring Period
End Date	the Adherence Date (dd/mm/yyyy) Minimum of 40 years and ideal maximum of 100 years counted from the Adherence Date (dd/mm/yyyy)	– start of the monitoring period (dd/mm/yyyy) Date established by the developer as the end of the EnS monitoring – end of the monitoring period (dd/mm/yyyy)

Where the Valuation Period starts on an Adherence Date prior to the signature of the PSA contract, proof of the start of the EnS provision must be presented, in accordance with the guidelines of the Methodology.

Table 88. Example Valuation Period table.

Project area	Supporting document for the start of EnS – Conservation of native vegetation	Adherence Date
Name of the Project Area	Document used to prove the start of the conservation practices	Date established by the developer on the basis of the supporting document

The information of the monitoring and verification period of the EnS must also be presented, in accordance with the table below:

Table 89. Example table of EnS verification period for the MCRMR.

Project area	EnS verification period	Annual cycle
Name of the project area	Monitoring period during which the EnS provided by the Project Area will be assessed	Credit lot

The registration of issued credits is structured based on annual periods associated with verification within monitoring periods, a time interval in which the EcS and agricultural practice indicators are evaluated and the results effectively obtained by the Project Area are measured. The generation of credits is directly linked to the area's performance in each of these monitoring periods in the verification process that consolidates the collected data and validates compliance with the practices and criteria established by the methodology. Once the verification is completed and the results confirmed, a batch of credits is issued referring exclusively to that period, divided by year. In this way, each monitoring cycle produces an independent batch of credits registered per year, ensuring traceability, transparency, and temporal adherence between the implementation of conservation practices and the generation of the respective environmental benefits.

5.13 PROJECT BOUNDARIES

It is necessary to define the spatial boundaries that delimit the measurement area of the EcS and the EnS provided by the project, in accordance with the specific conditions of the Project Area and the guidelines of the Methodology.

Where the Project Area comprises more than one property, the Ecosystem Indicators and the Agricultural Practices Indicators may be calculated in an integrated manner, in accordance with the specific conditions of the Project Area and the guidelines of the Methodology.

Table 90. Guidance table for delimiting project spatial boundaries.

Spatial Boundaries	
Project Area	Present documentary basis and coordinates that allowed the delimitation of the area (e.g. CAR, property title record, maps, plans and other documents relevant to the delimitation of the Project Area). Present pertinent information demonstrating the configuration of the Project Area to be characterized in the CR and MR, in accordance with the guidelines of the Methodology. Present a map characterizing the Project Area. Present characterization in the items of "Characterization of the Project Area" in the relevant reports, in accordance with the guidelines of the Methodology.
Total Native Vegetation Area	Present the total native vegetation cover included in the Project Area, encompassing woody and non-woody native vegetation, in accordance with the specific conditions of the Project Area. Present a map of the vegetation physiognomies present in the area. Present characterization in the item of "Project Boundaries" in the relevant reports, in accordance with the guidelines of the Methodology. The database must be current and derived from official primary or secondary sources of recognized quality.
Woody Native Vegetation Area	Present the woody native vegetation cover included in the Project Area, considering primary or secondary woody native vegetation, in accordance with the specific conditions of the Project Area. The boundary of the woody native vegetation area is defined solely by the use class "Forest Formation", in accordance with the MapBiomas classification and the guidelines of the Methodology. The characterization must be set out in the item "Project Boundaries" of the relevant reports, in accordance with the guidelines of the Methodology. The database must be current and derived from official primary or secondary sources of recognized quality.
Agricultural Cultivation Area	Present a technical drawing or plan of the property for proof and geospatial reference of the Agricultural Cultivation Area, in accordance with the specific conditions of the Project Area. Present a declaration of area, in hectares, disregarding the access tracks. Present characterization in the item of "Project Boundaries" in the relevant reports, in accordance with the guidelines of the Methodology.
Area of Influence	Area intended for comparison in the surroundings of the Project Area for the verification of the Ecosystem Indicators and Agricultural Practices Indicators, in accordance with the specific conditions of the Project Area. The delimitation must consider (i) a minimum buffer of 1 km from the boundaries of the properties that make up the Project Area, and (ii) the properties of the SICAR in the Area of Influence, in accordance with the specific conditions of the Project Area. The applicable configuration (buffer, SICAR properties or both) must be defined per indicator. The characterization must be set out in the item "Project Boundaries" of the relevant reports, in accordance with the guidelines of the Methodology.

5.13.1 CHARACTERISATION OF THE PROJECT AREA

This item sets out guidance on the characterization of the Project Area so as to support the subsequent stages of the PSA project.

The Project Area is considered to be able to comprise areas belonging to more than one owner, in accordance with the specific conditions of the Project Area and the guidelines of the Methodology.

5.13.1.1 LOCATION

The location of the Project Area must be indicated in accordance with the parameters listed in the table below:

Table 91. Project Area location parameters.

Parameters	Description	Textual source
Biome	Indicate the biome(s) in which the Project Area is located	Official and updated governmental sources such as state platforms; IBGE; MMA and others
Name of the area	Characterize the name(s) of the property(ies) and ownership	Ownership documentation provided by the Owner
Municipalities	Indicate the municipality(ies) in which the Project Area is located	Official and updated governmental sources such as state platforms; IBGE and others
Hydrography	Characterize the hydrographic region in which the Project Area is located. Mention information relevant to the hydrography and the water resources of the Project Area.	Official and updated governmental sources such as state platforms; IBGE and others
Socio-economic	Characterize the socio-economic region in which the Project Area is located. Mention information relevant to the socio-economic aspects and the surrounding communities of the Project Area.	Official and updated governmental sources such as state platforms; IBGE

The cartographic products below must be presented as appropriate. The sources used for the preparation of the maps must be duly referenced, in accordance with the guidelines of the Methodology.

i. Location Map;
ii. Hydrography Map;
iii. Socio-economic Indicators Map.

The developer may present other maps that it considers appropriate.

5.13.1.2 COMPLIANCE WITH ELIGIBILITY CRITERIA

Describe and base how the Project Area meets each of the eligibility criteria set out in item 5.11.1. The table below provides guidance for the development of this item:

Table 92. Guidance table for compliance with eligibility criteria (documentary and location).

Documentary Criteria	
CAR	Present a description of the CARs of all the areas involved, where applicable. Mention information relevant to the CAR and the ownership of the areas.

Property title record and/or contracts	Use documents provided by the Owner, national source (SICAR), state and other sources of recognized quality. Present in tabular form, containing the name of the area (farm or property), which the property title record or contract relates to, as well as the geographical coordinates and the total area of the property.
Other documents	Present a description of all documents obtained. Mention information on the area, ownership and other information relevant to the eligibility of the property.
	Location Criteria
Overlap with protected areas	Search for updated geo-spatial data from official sources, such as governmental platforms and technical reports from recognized institutions, in accordance with the specific conditions of the Project Area. • Cavities and caves • Geological sites • Archaeological sites • Indigenous Lands • Quilombola Territories • Integral Protection Conservation Units Present a cartographic product with the result of the overlaps and describe them
APP and RL	Present a description of APPs and RLs identified, relating them to the property title records and to the holders, in accordance with the specific conditions of the Project Area. Present a cartographic product of the location of the APPs and RLs, where applicable
History of vegetation cover in the last 10 years	By means of historical land use and occupation data, present a comparison, using cartographic products, of the vegetation cover in the last 10 years prior to the start of the Valuation Period of the project. Use updated and official data sources, such as state platforms of geo-spatial data, MapBiomas and other sources of recognized quality.
History of Cultivation	By means of documents on age, species and other data, provide information regarding the history of the cultivation in the Project Area, in accordance with the specific conditions of the Project Area. Present cartographic products on the planting and plots, as needed. Use updated and official data sources, such as state platforms of geo-spatial data, MapBiomas and other sources of recognized quality.

In summary, the cartographic products below must be presented as appropriate.

i. Map of Overlap with protected areas;
ii. Map of APP and RL;
iii. Comparative maps of the historical land use in the 10 years prior to the Start of the Valuation Period.

5.13.1.3 LAND USE AND LAND COVER

Describe how the use and occupation of the soil in the Project Area takes place, in accordance with the parameters listed below:

Table 93. Land-use characterization parameters.

Parameters	Description

Use of Primary Data	Field survey or through interviews of all points of interest in the properties that will form the Project Area, in accordance with the specific conditions of the Project Area.
Use of Secondary Data	Survey of all points of interest in the properties that will form the Project Area, based on secondary data from official sources, such as state platforms of geo-spatial data, MapBiomas and other sources of recognized quality.

The cartographic products below must be presented.

i. Land Use and Occupation Map of the Project Area, containing all the Land uses in the area(s) of the project, in accordance with the specific conditions of the Project Area.

5.13.1.4 FAUNA AND FLORA

In this item, the general environmental characteristics of the biotic environment of the Project Area must be presented, including fauna and flora, in accordance with the specific conditions of the Project Area.

Flora

The characterization of the vegetation may be carried out by means of Primary Data, validated in the field, or by means of Secondary Data, from official sources of recognized quality, in accordance with the guidelines of the Methodology.

The parameters that must be considered for the collection of Primary and Secondary Data are set out below.

Table 94. Vegetation survey parameters.

Parameters	Description
Use of Primary Data	Field survey of all points of interest in the properties that will form the Project Area, in accordance with the specific conditions of the Project Area.
Use of Secondary Data	Survey of all points of interest in the properties that will form the Project Area, based on secondary data from official sources, such as state platforms of geo-spatial data, MapBiomas and other sources of recognized quality.

The characterization of the Project Area must contain, at a minimum, the attributes described in the table below:

Table 95. Vegetation characterization attributes.

Attributes	Description	Textual source (Secondary Data)	Primary Data
Biome	Indicate the biome(s) in which the Project Area is located	Official and updated governmental sources such as state platforms; IBGE; MMA and others	Field validation by means of the observation of plant species and typical forest structure of the Brazilian biomes.
Physiognomy	Characterize the physiognomy(ies)	Official and updated governmental sources	Field validation by means of the

Attributes	Description	Textual source (Secondary Data)	Primary Data
	present in the Project Area	such as state platforms; IBGE; MMA and others	observation of plant species and typical forest structure of the Brazilian biomes.
Stage of Ecological Succession	Characterize the stage of ecological succession in the Project Area	Satellite imagery and geoprocessing techniques and bibliographical references that can support the estimation of the stage of ecological succession.	Field validation by means of the observation of plant species and typical forest structure of the Brazilian biomes.
Degree of Vegetation Conservation	Characterize the degree of conservation of the vegetation in the Project Area	Satellite imagery and geoprocessing techniques and bibliographical references that can support the estimation of the degree of conservation of the vegetation.	Field validation by means of the observation of plant species and typical forest structure of the Brazilian biomes.
Formation of Continuous Vegetation Corridors	Verify the continuity and connection of vegetation fragments, with a view to identifying potential continuous corridors and ecological corridors.	Satellite imagery and geoprocessing techniques that can support the estimation of the degree of connectivity and the presence of continuous vegetation corridors.	Field validation, by means of the observation of the forest structure, continuity and connection of the vegetation fragments.

The characterization of the vegetation will have the purpose of providing a diagnosis on the vegetation of the Project Area, to support the subsequent stages of the PSA project.

Regarding the vegetation of the Project Area, the cartographic products below must be presented, as appropriate.

- Biome and Physiognomy Map;
- Land Use and Cover Map, including the vegetation;
- Map containing Project Area and surrounding landscape, including potential disturbance factors and ecological corridors.

<u>Fauna</u>

The characterization of fauna may be carried out by means of Secondary Data, through a bibliographical review of the region of the Project Area, or by means of Primary Data, validated in the field, in accordance with the guidelines of the Methodology.

The search must be carried out by taxonomic groups (mammalian fauna, herpetofauna, etc.), since the interdependence between the species and the ecosystems is fundamental for the characterization of fauna.

A list of species of possible occurrence for the Project Area must be presented, containing, at a minimum, the following information:

i. Scientific name;
ii. Common name;
iii. Taxonomic classification;
iv. Threat status (on the basis of national and global lists);
v. Sources consulted.

It is further recommended that any other information considered relevant be inserted, such as habitat, diet, ecological behavior and other relevant information for the characterization of fauna.

The chance encounters with local fauna during the monitoring carried out in situ by the Monitoring Agent must also be considered in the lists. Encounters with fauna specimens may be recorded by means of photographs, accounts and other verifiable evidence, in accordance with the guidelines of the Methodology.

5.13.1.5 ACTIVITIES CARRIED OUT

Describe all the activities carried out in the Project Area, addressing, at a minimum:

ii. Economic activities;
iii. Cultural activities;
iv. Social and environmental activities.
v. Productive activities.

Official governmental textual sources or sources derived from accounts of the holders must be used, in accordance with the guidelines of the Methodology.

The agricultural activities carried out in the Project Area must be reported in a clear and verifiable manner, in accordance with the specific conditions of the Project Area and the guidelines of the Methodology.

5.13.1.6 ENVIRONMENTAL SERVICES PROVIDED

Describe all the EnS provided in the Project Area, mainly those linked to the conservation of native vegetation and to the implementation of good agricultural practices, in accordance with the specific conditions of the Project Area.

Official governmental textual sources or sources derived from accounts of the holders must be used, in accordance with the guidelines of the Methodology.

5.14 METHODOLOGICAL ADAPTATIONS

Describe and justify any methodological adaptations applied to the activity of the PSA project, in accordance with the guidelines of the Methodology, taking into account the following aspects:

- The adaptation does not have a negative impact on the conservative estimate relating to the carbon stock and the sequestration of carbon in the Project Area.

- The adaptation relates only to the criteria and procedures of estimation, monitoring and verification of the EcS and EnS provided, in accordance with the guidelines of the Methodology.

6 MONITORING

This item provides guidance on (i) the monitoring methods determined by the Methodology and (ii) the Monitoring Plan, which must be adopted by the developer for the assessment of the performance of the PSA project and the verification of the Ecosystem Services and Environmental Services provided.

6.1 MONITORING METHODS

It is emphasized that, irrespective of the method selected for monitoring, it is necessary to ensure the traceability of the information and the verification of the EcS and EnS provided, in accordance with the guidelines of the Methodology.

6.1.1 MONITORING AGENT

The Monitoring Agent, in so far as environmental monitoring is concerned, has the function of collecting information in situ that supports the development and verification of the Ecosystem Indicators and EcS present in the Project Area, in accordance with the guidelines of the Methodology.

Its functions include:

i. Sending of geo-referenced information, in the format of text, forms, photographs, among others, that support the development and verification of the Ecosystem Indicators and EcS present in the Project Area;
ii. Provision of information requested by the developer for the validation of the Biodiversity Indicators (see item 5.2.6;
iii. Monitoring of the progress of the PSA project and reporting of the occurrence of disturbance events, such as fires, pests, diseases, erosion and other disturbance vectors.

6.1.2 AGRICULTURAL MANAGEMENT REPORTS

To assess the performance of the agricultural management and the application of good agricultural practices that influence the ecosystems of the Project Area, the developer must present agricultural management reports, in accordance with the guidelines of the Methodology.

The EnS Provider, in the figure of the Monitoring Agent, must provide information on the performance of the agricultural management, which must be reported in the CR (see item 7.1 Methodology Compliance Report). Information such as that listed below, or other information pertinent to the agricultural management process, must be provided:

i. Occurrence of invasion;
ii. Occurrence of harvest loss;
iii. Occurrence of changes in the production process;
iv. Occurrence of changes in monitoring;

v. Occurrence of incidents, accidents or adverse impacts;
vi. List of agrochemicals and fertilizers used in the cultivation areas;
vii. Registration of plots;
viii. Fertilization input data;
ix. Operational procedures;
x. Rotation of chemical groups;
xi. Forest fire action plan.

The information must be reported in a systematic manner.

6.1.3 REMOTE SENSING

By means of GIS, remote-sensing techniques may be used with the aim of monitoring the vegetation cover, land use and changes in the Project Area, in accordance with the guidelines of the Methodology.

Remote-sensing assessment must follow the guidelines below:

Table 96. Remote-sensing data used for the CR and MR.

	Data Use
Satellite Imagery	The use of satellite imagery, with a resolution of 30 meters (LandSat or Sentinel), or higher, must be used for the monitoring of the vegetation cover and of the land use in the Project Area.
Secondary Data	Remote-sensing techniques may be combined with Secondary Data from publicly available projects, such as MapBiomas, Prodes and other platforms of recognized quality.
Drones	Drones with high-resolution RGB cameras may be used for the monitoring of vegetation cover and of the agricultural management in the Project Area, in accordance with the specific conditions of the Project Area.
	Application
Monitoring of forest cover in the Project Area	This is surveillance monitoring. Remote Sensing assists in the verification of changes in vegetation cover, land use and the presence of disturbance vectors in the Project Area. This monitoring must be carried out periodically by the developer, who must, in turn, report the results in the MR, in accordance with the guidelines of the Methodology.
Monitoring of Loss Risks	This is surveillance monitoring. Remote Sensing assists in the verification of loss risks associated with disturbance vectors, such as fires, pests, diseases, erosion and other disturbance vectors, in the Project Area. This monitoring must be carried out periodically by the developer, who must, in turn, report the results in the MR, in accordance with the guidelines of the Methodology.

6.1.4 FOREST INVENTORY

Where the forest inventory method has been adopted (item 5.2.1.1.4.1 Forest inventory), the developer may take into account the same sampling design (allocation of plots) for the monitoring of the carbon stock in the Project Area, in accordance with the guidelines of the Methodology.

Consult the method in item 5.2.1.1.4.1 Forest inventory of this Methodology.

6.1.5 NON-DECREASE DEMONSTRATION METHOD

The non-decrease demonstration method is based on the approaches suggested by the IPCC, and may be used for the monitoring of the carbon stock in the Project Area, in accordance with the guidelines of the Methodology.*AR-TOOL14 – Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities.*.[114]

This method is considered efficient where there is a need to present a Monitoring Report, especially in situations where the carbon stock remains stable or increases over time.

Accordingly, the Methodology applies the "non-decrease demonstration" method, which consists of verifying whether the carbon stock in the Project Area is maintained or increased over time, in accordance with the guidelines of the Methodology.

By this monitoring method, each physiognomy identified in the Project Area must be monitored individually, in accordance with the specific conditions of the Project Area and the guidelines of the Methodology.

In strata whose revisited estimate is outside (that is, greater or less than) the confidence interval established, the non-decrease demonstration method cannot be applied, and the developer must use other monitoring methods to assess the carbon stock in the Project Area.

This method is applicable only to estimates directed at the monitoring of the Project Area, in accordance with the guidelines of the Methodology, taking into account the following conditions:

i. No timber extraction occurred in the strata since the previous estimate;
ii. The stratum was not affected by any disturbance (for example, pest, fire) that could decrease the carbon stock;
iii. The tree canopy cover in the stratum remained the same since the previous estimate.

For the analysis and confirmation of the conditions listed, remote-sensing techniques, satellite imagery and other monitoring methods may be used, in accordance with the guidelines of the Methodology.

Once the three conditions in the Project Area have been confirmed, the non-decrease method may be considered applicable, in accordance with the guidelines of the Methodology.

For demonstration, all monitoring reports must prove the criteria mentioned, in accordance with the guidelines of the Methodology.

The non-decrease demonstration method must take precedence during the execution of the monitoring periods, in accordance with the guidelines of the Methodology.

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[114] A/R Methodological tool. Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities. Version 04.2. UNFCCC. Available at: https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v4.2.pdf

From the validation of the estimates of the above-ground and below-ground biomass stocks, the carbon stock in the Project Area may be monitored over time, in accordance with the guidelines of the Methodology.

Where the criteria listed for the application of the non-decrease method are not met, other monitoring methods must be used to assess the carbon stock in the Project Area, in accordance with the guidelines of the Methodology.

6.2 MONITORING PLAN

The purpose of the Monitoring Plan is for the developer to select the monitoring methods that will be adopted for the assessment of the performance of the PSA project and the verification of the Ecosystem Services and Environmental Services provided, in accordance with the guidelines of the Methodology.

The monitoring of the Project Area covers continuous activities for surveillance of the area, so as to ensure the traceability of the information and the verification of the EcS and EnS provided, in accordance with the guidelines of the Methodology.

The Ecosystem Indicators and Agricultural Practices Indicators will be subject to verifications, in accordance with the guidelines of the Methodology and the specific conditions of the Project Area.

The process and the schedule that will be adopted by the developer for the monitoring must be described, in accordance with the guidelines of the Methodology, considering the following aspects:

i. Description of the organizational structure, responsibilities and competences of the personnel carrying out the monitoring;
ii. Description of the methods used for the measurement, recording and storage of the data on monitored parameters;
iii. Description of the procedures used for the handling and any internal audit carried out;
iv. Description of the implementation of sampling approaches, including the levels of precision achieved;
v. Where applicable, demonstration of whether the required level of confidence or precision has been met;
vi. Where applicable, description of the functions and reports of the Monitoring Agent(s).

The table below presents the monitoring modules that must be carried out in the PSA Carbonflor project:

Table 97. PSA Carbonflor Monitoring Guideline.

Monitoring	Activity	Periodicity	Report
Monitoring of the Implementation of the PSA project	Surveillance and Verification	Constant	MR
Vegetation cover monitoring	Surveillance	Annual	
Monitoring of Environmental Disturbances	Surveillance	Annual	

Monitoring of changes in the Ecosystem Indicators and Agricultural Practices Indicators	Verification of the values obtained	1 to 5 years
Agricultural management monitoring	Surveillance and Verification	Annual

i. **Monitoring of the Implementation of the PSA project:** Continuous monitoring of the internal management processes and operations of the property(ies) comprising the Project Area, with in situ monitoring for the management team of the PSA Carbon Agro Perene, for appropriate recording and methodological calculations;
ii. **Vegetation cover monitoring:** Annual monitoring, by means of geoprocessing techniques, for the verification of changes in vegetation cover and land use in the Project Area;
iii. **Monitoring of environmental disturbances:** Annual monitoring by means of remote sensing and official databases, for the verification of the occurrence of environmental disturbances, such as fires, pests, diseases, erosion and other disturbance vectors;
iv. **Monitoring of changes in the Ecosystem Indicators and Agricultural Practices Indicators:** Measurement of the Ecosystem Indicators and Agricultural Practices Indicators, applying one of the monitoring methods mentioned in item 6.1. After the execution of the monitoring activities, the results must be reported in the MR, in accordance with the guidelines of the Methodology;
v. **Agricultural management monitoring:** Systematic recording of changes and processes involving agricultural cultivation, applying one of the monitoring methods mentioned in item 6.1. After the execution of the monitoring activities, the results must be reported in the MR, in accordance with the guidelines of the Methodology.

In this item, the monitoring to be carried out, the monitoring activities and their periodicity must be listed, in accordance with the guidelines of the Methodology.

6.3 VERIFICATION OF ECOSYSTEM AND ENVIRONMENTAL SERVICES

Item relating to the results of the Monitoring Plan. The results of the monitoring and verification of the EcS and EnS provided must be described and evidence must be provided, in accordance with the guidelines of the Methodology.

All the monitoring methods that the developer deems necessary and appropriate must be used, in accordance with the guidelines of the Methodology.

The monitoring methods defined by the developer, that is to say, the parameters selected for the monitoring of the EcS and EnS provided, must be described in the MCR and MR, in accordance with the guidelines of the Methodology.

Those methods, once monitored by means of primary data, may not be switched to secondary data in subsequent periods, in accordance with the guidelines of the Methodology.

This item provides guidance on the preparation of the Monitoring Report, the instructions for which are set out in item 7.2.

It is emphasized the importance of describing any occurrence that interferes with the project, such as:

i. Information on events that may impact the carbon storage or sequestration and the generation of credits, in accordance with the guidelines of the Methodology;
ii. Where applicable, describe how the project risk factors, including those relating to disturbance vectors, are being addressed, in accordance with the guidelines of the Methodology;
iii. Any other changes (for example, for project developers and other entities involved) that may influence the performance of the project, in accordance with the guidelines of the Methodology.

7 REPORTS COMPRISING THE METHODOLOGY

Two types of reports are provided for the project period: the Methodology Compliance Report (MCR) and the Monitoring Report (MR), in accordance with the guidelines of the Methodology.

Table 98. Products of the Methodology.

Report	MCR	MR	MCRMR
Description	Methodology application report determining (i) characterization, (ii) measurement criteria, (iii) selection of indicators and (iv) Monitoring Plan of the Project Area, in accordance with the guidelines of the Methodology.	Report reaffirming the compliance of the assumptions determined in the MCR and attesting the results of the monitoring of the Project Area, in accordance with the guidelines of the Methodology.	Report comprising the combination of the first MCR and the result of the first monitoring, in accordance with the guidelines of the Methodology.
Frequency	N/A	Intervals of 1 to 5 years, in accordance with the compliance identified by the developer on the basis of the monitoring activities carried out.	N/A
Condition	The document must be produced after formalization of commitment to the PSA by means of contract or equivalent instrument, in accordance with the guidelines of the Methodology.	May only be issued after the CR, where monitoring activities have been carried out for a given period, in accordance with the guidelines of the Methodology.	Simultaneous occurrence is only possible where there is valuation prior to the signature of the contract for the PSA project, in accordance with the guidelines of the Methodology.

The verification of compliance with the Methodology is the independent assessment of the project by the institution responsible for the certification of the PSA project, in accordance with the guidelines of the Methodology.

The Monitoring Report may only be prepared after the first monitoring event has been carried out, in accordance with the guidelines of the Methodology.

The following are general and specific requirements for the reports:

i. Compliance with the Methodology may occur before the first monitoring or at the same time as the first monitoring, in accordance with the guidelines of the Methodology.
ii. The applicable report must clearly evidence any material errors, omissions and deficiencies in the implementation of the project, in accordance with the guidelines of the Methodology.
iii. The materiality threshold in respect of the error associated, omissions and misrepresentations relating to the assumptions and estimates of the project must be established in accordance with the guidelines of the Methodology.
iv. Where an Owner or a Project Area presents a scenario of deviation from the Methodology, the developer must justify that deviation in the MCR and MR, in accordance with the guidelines of the Methodology.

7.1 METHODOLOGY COMPLIANCE REPORT (MCR)

The Methodology Compliance Report (MCR) has the purpose of describing how the characteristics of the Project Area meet the requirements of the Methodology, in accordance with the guidelines of the Methodology.

An executive summary must be presented containing, in a summarized manner, the main information of the project, in accordance with the guidelines of the Methodology.

The MCR must contain the items indicated and detailed below:

Table 99. MCR Summary.

Item	Description
Introduction	Brief description of the project and its objectives, in accordance with the scope of EcS generation by means of the EnS provided, in accordance with the guidelines of the Methodology.
PSA Carbon Agro Perene Guidelines	Take up again, where applicable, the guidelines set out for the purposes of contextualizing the project. See item 4
Developer	Presentation of the company or organization responsible for the preparation of the MCR, following the guidelines of the Methodology.
Entities Involved	Description of any companies and/or organizations involved in the MCR in the modalities of: i. financing; ii. preparation of technical pieces; offering of products
Strategic Public	Definition of which persons or groups of interest will be impacted and may impact on the activities of the PSA project, in accordance with the guidelines of the Methodology.

Item	Description
Definitions of Eligibility Criteria of the Methodology	Indication and presentation of justification for the eligibility criteria in accordance with Brazilian legislation and the guidelines of the Methodology, see item 5.11.1
Project Periods	Description and presentation of justification for the parameters determining the periods considered for the PSA project, in accordance with the guidelines of the Methodology, see items 5.12 and 5.12.1
Project Boundaries	Description and characterization of the pertinent project boundaries, in accordance with the instructions of item 5.13. Sub-items: i. Project Area; ii. Woody Native Vegetation Area – WNVA iii. Total Native Vegetation Area – TNVA iv. Agricultural Cultivation Area; v. Area of Influence
Characterization of the Project Area	Characterization of the Project Area and its particularities for contextualization of the analysis area, see item 5.13.1. Sub-items: i. Location; ii. Compliance with eligibility criteria; iii. Land Use and Cover; iv. Fauna and Flora; v. Activities Carried Out; vi. Environmental Services Provided
Ecosystem Services	Description of the EcS that will be selected by the developer and that encompass the Project Area, see item 5.1.2
Ecosystem Indicators Selected	List of the Ecosystem Indicators and justification for the choice of each one, in accordance with item 5.2 Ecosystem Indicators and Ecosystem Services .
Good Practices Indicators Selected	List of the Agricultural Practices Indicators and justification for the choice of each one, in accordance with item 5.3 Agricultural Practices Indicators.
SDG Selection	Identification, justification and framing of the Sustainable Development Goals (SDGs) selected by the developer, in accordance with the guidelines of the Methodology.
Monitoring Plan	Description of the monitoring methods and the methodology for the monitoring plan that will be adopted by the developer, see items 6, 6.1 (and sub-items) and 6.2.
Appendices and annexes	As needed, inclusion of appendices and annexes relating to the project

7.2 MONITORING REPORT (MR)

The Monitoring Report (MR) has the purpose of describing the results obtained by the project during the monitoring period, in accordance with the guidelines of the Methodology.

An executive summary must be presented containing, in a summarized manner, the main information of the project, in accordance with the guidelines of the Methodology.

The Monitoring Report must contain the items indicated and detailed below:

Table 100. MR Summary.

Item	Description
MCR Basis	Brief description of the project and its objectives in accordance with the determinations established in the MCR, containing pertinent information for the contextualisation of the monitoring period, in accordance with the guidelines of the Methodology.
Monitoring Period	Indication of the monitoring period in which the activities were carried out and EnS are being provided, in accordance with the guidelines of the Methodology.
Verification of the Ecosystem Indicators	The Ecosystem Indicators selected in the MCR must be developed and assessed for the monitoring period, in accordance with item 5.2 Ecosystem Indicators and Ecosystem Services . See also the instructions of item 6.3.
Verification of Agricultural Practices Indicators	The Agricultural Practices Indicators selected in the MCR must be developed and assessed for the monitoring period, in accordance with item 5.3 Agricultural Practices Indicators. See also the instructions of item 6.3.
Verification of the Selected SDGs	Assessment of the project in relation to the Sustainable Development Goals (SDGs) selected by the developer, in accordance with the guidelines of the Methodology.
Ecosystem Indicators Matrix	Presentation of the Ecosystem Indicators Matrix to summarize the scoring of all the Ecosystem Indicators selected by the developer, see item 5.5
Agricultural Practices Matrix	Presentation of the Agricultural Practices Indicators Matrix to summarize the scoring of all the Agricultural Practices Indicators selected by the developer, see item 5.6.
Verification of Environmental Services	Demonstration of the results of monitoring and verification that the EnS provided have been effectively delivered, in accordance with the guidelines of the Methodology. The developer must find the best way of presenting the results directed by the methods of the Monitoring Plan (item 6.2) determined in the MCR. See also the instructions of item 6.3. This item must include any influences of environmental disturbances in accordance with the Methodology (see item 6.3 and sub-items)
C+ of Native Stock	Analysis of the data resulting from the analysis of the indicators, the conversion into carbon (item 5.7.2), the deduction of reversals and safety reserve (where applicable) and the final stock of tradable C+, in accordance with the guidelines of the Methodology. Definition of the percentage of carbon stock adopted by the project to make up the Safety Reserve, see item 5.7.3. Carry out the appropriate carbon stock deductions in accordance with the guidelines of the Methodology.
C+ of Cultivation	Analysis of the data resulting from the analysis of the indicators, the conversion into carbon (item 5.8.1), the deduction of reversals and safety reserve (where applicable) and the final stock of tradable C+, in accordance with the guidelines of the Methodology. Definition of the percentage of carbon stock adopted by the project to make up the Safety Reserve, see item 5.8.2. Carry out the appropriate carbon stock deductions in accordance with the guidelines of the Methodology.

Item	Description
Final Estimates	After all the calculations and conversions in accordance with the determinations of the Methodology, presentation of the final values of tradable C+ for the monitoring period, in accordance with the guidelines of the Methodology.
Methodology Deviation	Where applicable, description of the methodological deviations adopted by the project, as well as the justification for those deviations, in accordance with item 5.14
Conclusions	Considerations regarding the results obtained in the monitoring period considered
Appendices and Annexes	As needed, inclusion of appendices and annexes relating to the project

7.3 METHODOLOGY COMPLIANCE REPORT AND MONITORING REPORT (MCRMR)

Where the Methodology Compliance Report and Monitoring Report are applicable simultaneously, in accordance with the guidelines of item 7, the developer may prepare a joint report, the MCRMR.

The MCRMR must contain the items indicated and detailed below:

Table 101. MCRMR Summary.

Item	Description
Introduction	Brief description of the project and its objectives, in accordance with the scope of Ecosystem Services generation by means of the EnS provided, in accordance with the guidelines of the Methodology.
PSA Carbon Agro Perene Guidelines	Take up again, where applicable, the guidelines set out for the purposes of contextualizing the project. See item 4
Developer	Presentation of the company or organization responsible for the preparation of the MCR, following the guidelines of the Methodology.
Entities Involved	Description of any companies and/or organizations involved in the MCR in the modalities of: iii. financing; iv. preparation of technical pieces; offering of products
Strategic Public	Definition of which persons or groups of interest will be impacted and may impact on the activities of the PSA project, in accordance with the guidelines of the Methodology.
Definitions of Eligibility Criteria of the Methodology	Indication and presentation of justification for the eligibility criteria in accordance with Brazilian legislation and the guidelines of the Methodology, see item 5.11.1
Project Periods	Description and presentation of justification for the parameters determining the periods considered for the PSA project, in accordance with the guidelines of the Methodology, see items 5.12 and 5.12.1
Project Boundaries	Description and characterization of the pertinent project boundaries, in accordance with the instructions of item 5.13. Sub-items: vi. Project Area; vii. Woody Native Vegetation Area – WNVA viii. Total Native Vegetation Area – TNVA ix. Agricultural Cultivation Area – ACA; Area of Influence

Item	Description
Characterization of the Project Area	Characterization of the Project Area and its particularities for contextualization of the analysis area, see item 5.13.1. Sub-items: vii. Location; viii. Compliance with eligibility criteria; ix. Land Use and Cover; x. Fauna and Flora; xi. Activities Carried Out; Environmental Services Provided
Ecosystem Services	Description of the EcS that will be selected by the developer and that encompasses the Project Area, see item 5.1.2
Ecosystem Indicators Selected	List of the Ecosystem Indicators and justification for the choice of each one, in accordance with item 5.2 Ecosystem Indicators and Ecosystem Services .
Good Practices Indicators Selected	List of the Agricultural Practices Indicators and justification for the choice of each one, in accordance with item 5.3 Agricultural Practices Indicators.
SDG Selection	Identification, justification and framing of the Sustainable Development Goals (SDGs) selected by the developer, in accordance with the guidelines of the Methodology.
Monitoring Plan	Description of the monitoring methods and the methodology for the monitoring plan that will be adopted by the developer, see items 6, 6.1 (and sub-items) and 6.2.
Verification of the Ecosystem Indicators	The Ecosystem Indicators selected in the MCR must be developed and assessed for the monitoring period, in accordance with item 5.2 Ecosystem Indicators and Ecosystem Services . See also the instructions of item 6.3.
Verification of Agricultural Practices Indicators	The Agricultural Practices Indicators selected in the MCR must be developed and assessed for the monitoring period, in accordance with item 5.3 Agricultural Practices Indicators. See also the instructions of item 6.3.
Verification of the Selected SDGs	Assessment of the project in relation to the Sustainable Development Goals (SDGs) selected by the developer, in accordance with the guidelines of the Methodology.
Ecosystem Indicators Matrix	Presentation of the Ecosystem Indicators Matrix to summarize the scoring of all the Ecosystem Indicators selected by the developer, see item 5.5
Agricultural Practices Matrix	Presentation of the Agricultural Practices Indicators Matrix to summarize the scoring of all the Agricultural Practices Indicators selected by the developer, see item 5.6.
Verification of Environmental Services	Demonstration of the results of monitoring and verification that the EnS provided have been effectively delivered, in accordance with the guidelines of the Methodology. The developer must find the best way of presenting the results directed by the methods of the Monitoring Plan (item 6.2) determined in the MCR. See also the instructions of item 6.3. This item must include any influences of environmental disturbances in accordance with the Methodology (see item 6.3 and sub-items)
C+ of Native Stock	Analysis of the data resulting from the analysis of the indicators, the conversion into carbon (item 5.7.2), the deduction of reversals and safety reserve (where applicable) and the final stock of tradable C+, in accordance with the guidelines of the Methodology. Definition of the percentage of carbon stock adopted by the project to make up the Safety Reserve, see item 5.7.3. Carry out the

Item	Description
C+ of Cultivation	appropriate carbon stock deductions in accordance with the guidelines of the Methodology. Analysis of the data resulting from the analysis of the indicators, the conversion into carbon (item 5.8.1), the deduction of reversals and safety reserve (where applicable) and the final stock of tradable C+, in accordance with the guidelines of the Methodology. Definition of the percentage of carbon stock adopted by the project to make up the Safety Reserve, see item 5.8.2. Carry out the appropriate carbon stock deductions in accordance with the guidelines of the Methodology.
Final Estimates	After all the calculations and conversions in accordance with the determinations of the Methodology, presentation of the final values of tradable C+ for the monitoring period, in accordance with the guidelines of the Methodology.
Methodology Deviation	Where applicable, description of the methodological deviations adopted by the project, as well as the justification for those deviations, in accordance with item 5.14
Conclusions	Considerations regarding the results obtained in the monitoring period considered
Appendices and Annexes	As needed, inclusion of appendices and annexes relating to the project

8 REFERENCE LEGISLATION

This Methodology is based on the guidelines and definitions of the Reports of the Intergovernmental Panel on Climate Change (IPCC) and of the Brazilian legislation applicable to the environmental area, in accordance with the guidelines of the Methodology.

Table 102. Reference legislation.

Rule	Summary
Law No. 12,187/2009	Establishes the National Policy on Climate Change – PNMC.
Decree No. 9,578/2018	Consolidates normative acts issued by the federal Executive Branch concerning the National Fund on Climate Change and the National Policy on Climate Change.
Decree No. 10,144/2019	Establishes the National Commission for the Reduction of Greenhouse Gas Emissions from Deforestation and Forest Degradation.
MMA Ordinance No. 288/2020	Establishes the National Program of Payments for Environmental Services – Floresta+, within the scope of the Ministry of the Environment.
MMA Ordinance No. 518/2020	Establishes the Floresta+ Carbon Modality.
Law No. 14,119/2021	Establishes the National Policy on Payment for Environmental Services (PSA).
Decree No. 10,828/2021	Regulates the issuance of the Rural Product Certificate, relating to activities of conservation and recovery of native vegetation.
Decree No. 11,550/2023	Sets out provisions on the Interministerial Committee on Climate Change.”

Rule	Summary
Law No. 15,024/2024	Establishes the Brazilian System of Greenhouse Gas Emissions Trading (SBCE).
Acre – State Law No. 2,308/2010	Creates the State System of Incentives for Environmental Services – SISA, the Program of Incentives for Environmental Services of Carbon (ISA Carbon) and other environmental services programs.
Acre – State Law No. 2,025/2008	Creates the State Program of Certification of Family Productive Units of the State of Acre.
Bahia – State Law No. 13,233/2015	Establishes the State Policy on Payment for Environmental Services, the State Program of Payment for Environmental Services and other provisions.
Federal District – Law No. 5,955/2017	Establishes the District Policy on Payment for Environmental Services and the District Program of Payment for Environmental Services.
Espírito Santo – State Law No. 9,864/2012	Sets out provisions on the reformulation of the Program of Payment for Environmental Services and PSA in the State established by Law No. 8,995/2008.
Espírito Santo – SEAMA Ordinance No. 20-R/2013	Sets out provisions on the rules for the recognition of land-use modalities as generators of environmental services.
Goiás – State Decree No. 9,130/2017	Sets out provisions on the State Program of Payment for Environmental Services – PEPSA – and other provisions.
Goiás – State Law No. 18,104/2013	Sets out provisions on the protection of native vegetation, establishes the new Forest Policy of the State of Goiás and other provisions.
Maranhão – State Law No. 11,578/2021	Establishes the Policy for the Reduction of Greenhouse Gas Emissions from Deforestation and Forest Degradation.
Mato Grosso – State Law No. 9,878/2013	Creates the State System of Reduction of Emissions from Deforestation and Forest Degradation, Conservation, Sustainable Management and Enhancement of Forest Carbon Stocks (REDD+) and other provisions.
Mato Grosso – State Law No. 8,580/2006	Sets out provisions on the state policy of support for projects for the generation of carbon credits and other provisions.
Mato Grosso do Sul – State Law No. 5,235/2018	Sets out provisions on the State Policy of Preservation of Environmental Services, creates the State Program of Payment for Environmental Services and other provisions.
Mato Grosso do Sul – SEMAGRO Resolution No. 717/2020	Establishes the Program – PSA Multiple Use Scenic Rivers Modality of Payment for Environmental Services.
Minas Gerais – State Decree No. 45,229/2009	Regulates measures of the Public Authority of the State of Minas Gerais relating to climate change mitigation and other provisions.
Minas Gerais – State Law No. 20,922/2013	Sets out provisions on forest policies and biodiversity protection in the State.
Minas Gerais – IEF Ordinance No. 28/2020	Establishes guidelines for the registration of planting and harvest of planted forests with native species.
Minas Gerais – State Decree No. 48,127/2021	Regulates, in the State, the Program of Environmental Regularization, provided for in Federal Law No. 12,651/2012.

Rule	Summary
Paraíba – Ordinary Law No. 10,165/2013	Sets out provisions on the State Policy of Payment for Environmental Services, authorizes the establishment of the State Fund and other provisions.
Paraná – State Law No. 17,134/2012	Establishes Payment for Environmental Services, particularly those provided by Biodiversity Conservation and other provisions.
Paraná – SEMA Resolution No. 80/2015	Establishes guidelines and rules for the execution of Payment for Environmental Services projects and other provisions.
Pernambuco – State Law No. 15,809/2016	Establishes the State Policy on Payment for Environmental Services, creates the State Program of Payment for Environmental Services and other provisions.
Rio de Janeiro – CERHI Resolution No. 227/2020	Sets out provisions on the State Registry of Payment for Environmental Services – PRO-PSA.
Rio de Janeiro – State Law No. 5,690/2010	Establishes the State Policy on Global Climate Change and Sustainable Development.
Rondônia – State Law No. 4,437/2018	Establishes the State Policy on Climate Governance and Environmental Services – PGSA and creates the State System.
Santa Catarina – State Law No. 15,133/2010	Establishes the State Policy on Environmental Services and regulates the State Program of Payment for Environmental Services.
São Paulo – SMA Resolution No. 89/2013	Establishes the guidelines for the execution of the Payment for Environmental Services Project for Water Resources Conservation.
São Paulo – SMA Resolution No. 86/2017	Establishes the Payment for Environmental Services Project for Native Vegetation Protection – PSA Native Vegetation.
São Paulo – State Law No. 13,798/2009	Establishes the State Policy on Climate Change – PEMC.
São Paulo – Decree No. 66,549/2022	Disciplines the application, within the scope of the State of São Paulo, of Federal Law No. 14,119 of 13 January 2021.

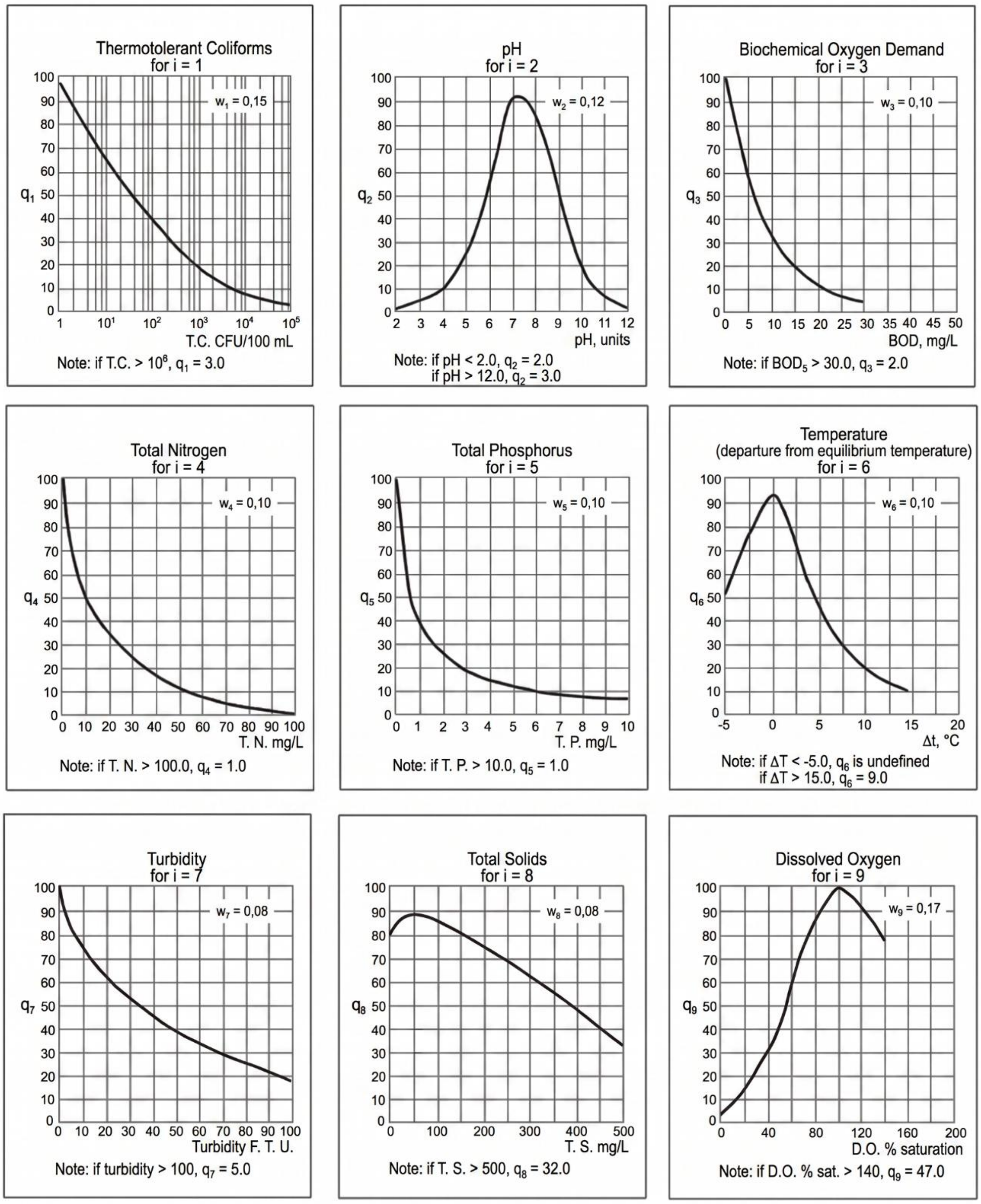
Annex I. Example table of EcS derived from the CICES classification

Section	Division	Group	Class	*EcS Description*	*Example of gain*
Provisioning	Genetic Material of the entire biotic environment (including seeds, spores and gamete production)	Genetic material of plants, algae and fungi	Seeds, spores and other plant materials collected to maintain or establish a population	Seed collection	Seeds or spores that can be collected.
			Vascular and non-vascular plants (whole organisms) used to create new lineages or varieties	Plants, fungi or algae that can be used for reproduction.	Population of species of plants, algae or fungi used in breeding programs.
			Individual genes extracted from vascular and non-vascular plants for the design and construction of new biological entities	Genetic material of native plants, fungi or algae that can be used.	Harvestable portion of the population of plant species used to extract genes.
		Genetic material of animals	Animal material collected to maintain or establish a population	Animals used to replenish stock	Larvae for mollusk and fish farms
			Wild animals (whole organisms) used to create new lineages or varieties	Wild animals that we can use for reproduction	Population of animals used in breeding programs.
		Genetic material of organisms	Individual genes extracted from organisms for the design and construction of new biological entities	Genetic information stored in wild organisms that can be used	Harvestable portion of the population of a given species used to extract genes
Regulation	Regulation of physical, chemical and biological conditions	Regulation of baseline flows and extreme events	Control of erosion rates	Control or prevention of soil loss	The capacity of the vegetation to prevent or reduce the incidence of soil erosion Or Macroalgae, microphytobenthos, macrophytes and biogenic reef structures (epifauna and infauna) as means of controlling erosion.
			Cushioning and attenuation of mass movement	Preventing landslides and avalanches from harming people	The capacity of the forest cover to prevent or mitigate the extent and force of snow avalanches.
			Regulation of the hydrological cycle and water flow (including flood control and coastal protection)	Regulation of water flows in the environment.	The capacity of the vegetation to retain water and release it slowly, and others.
		Maintenance of life cycle and protection	Pollination (or dispersal of 'gametes' in a marine context)	Pollination of fruit trees and other plants	Provision of habitat for native pollinators.

Section	Division	Group	Class	*EcS Description*	*Example of gain*
Provisioning		of habitat and gene pool	Seed dispersal	Spreading seeds of wild plants	Dispersal of nuts and seeds by birds
			Maintenance of populations and nursery habitats (including protection of the gene pool)	Provide habitats for wild plants and animals that may be useful for human beings	Important habitats for nurseries include estuaries, seagrasses, algal forests, swamps and other coastal ecosystems. Floating clusters of seaweed (macroalgae) form rafts under which juvenile fish find shelter and food.
		Regulation of soil quality	Weathering processes and their effects on soil quality	Ensuring that soils form and develop	Release of inorganic nutrients in cultivated fields
			Decomposition and fixation processes and their effects on soil quality	Ensuring that organic matter in soils is maintained	Decomposition of plant residues; Nitrogen fixation
		Atmospheric composition and conditions	Regulation of the chemical composition of the atmosphere and oceans	Regulation of global climate	Carbon sequestration in tropical peat bogs
			Regulation of temperature and humidity, including ventilation and transpiration	Regulation of physical air quality for humanity	Evaporative cooling provided by urban trees
	Water	Surface waters used for nutrition, materials or energy	Surface waters for drinking purposes	Drinking water from sources on the soil surface	Volume and characteristics of the water of a natural spring
			Surface waters used as material (for non-drinking purposes)	Surface waters that may be used for things other than drinking	Temperature and volume of water that may be used for cooling or irrigation
			Surface waters used as a source of energy	Hydroelectric energy	Hydraulic potential

Annex II. Mean water quality variation curves

Figure 6. Mean quality variation curves.



Source: CETESB, 2021[115]

[115] Available at: https://cetesb.sp.gov.br/wp-content/uploads/sites/12/2022/11/Apendice-E-Indices-de-Qualidade-das-Aguas.pdf

Annex III. Comparison of SDG targets with project indicators and recommended supporting documentation for demonstrating compliance with each target

1. Eradication of poverty

1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than USD 1.25 a day.

How to measure: Present the number of people directly and indirectly impacted economically by the project, as well as the project's contribution to the reduction of extreme poverty, with supporting evidence.

1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions, according to national definitions.

How to measure: Present the number of people directly and indirectly impacted economically by the project, separately by gender, age and ethnicity, demonstrating the project's contribution to the reduction of poverty.

1.4 By 2030, ensure that all men and women, particularly the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, new appropriate technologies and financial services, including microfinance.

How to measure: Present the number of people directly and indirectly impacted economically by the project, separately by gender, age and ethnicity, demonstrating the project's contribution to equality of access to economic resources.

1.5 By 2030, build the resilience of the poor and those in situations of vulnerability, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

How to measure: demonstrate that the project aims to reduce the effects of the climate crisis and evidence how it is contributing to build the resilience of the poor and of vulnerable populations to climate-related extreme events.

2. Zero hunger and sustainable agriculture:

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

How to measure: demonstrate that the project supplies such food and demonstrate how this reduces hunger, presenting evidence of that contribution.

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons.

How to measure: demonstrate that the project contributes to malnutrition and draw a parallel with those international targets, presenting evidence of the project's contribution.

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

How to measure: demonstrate that the project contributes to increasing the income of small-scale food producers, presenting evidence of that contribution.

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality.

How to measure: Demonstrate, where applicable, that the project adopts sustainable food production systems and resilient agricultural practices, presenting evidence of that contribution.

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants, farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international level, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

How to measure: Demonstrate whether there is genetic diversity of seeds, cultivated plants, farmed and domesticated animals on the Project Area, presenting evidence of that contribution.

3. Health and Well-being

3.1 By 2030, reduce the global maternal mortality ratio to less than 70 deaths per 100,000 live births.

How to measure: Demonstrate that the project produces food and how nutrition can reduce mortality, presenting evidence of that contribution.

3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.

How to measure: Demonstrate that the project produces food and how nutrition can reduce mortality, presenting evidence of that contribution.

3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, waterborne diseases and other communicable diseases.

How to measure: Demonstrate how the project contributes to an improvement in water quality and how this may entail a reduction in waterborne diseases, presenting evidence of that contribution.

3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.

How to measure: Demonstrate that the project produces food and how nutrition can reduce premature mortality, presenting evidence of that contribution.

3.7 By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programs.

How to measure: Inform whether the project offers workshops on those themes for the surrounding community, presenting evidence of that contribution.

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

How to measure: Demonstrate how the project contributes to an improvement in water quality and how this may entail a reduction in deaths and illnesses from hazardous chemicals and water pollution, presenting evidence of that contribution.

4. Quality education

4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.

How to measure: Inform whether the project offers schooling for the surrounding community and present evidence of that.

4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.

How to measure: Inform whether the project offers schooling for the surrounding community and present evidence of that.

4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.

How to measure: Inform whether the project offers schooling and/or technical education for adults of the surrounding community and present evidence of that.

4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

How to measure: Inform whether the project offers technical education and/or workshops for adults of the surrounding community and present evidence of that.

4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

How to measure: Where the project offers schooling and/or technical education for adults of the surrounding community, inform whether there are gender disparities and how the project contributes to their elimination.

4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.

How to measure: Where the project offers schooling and/or technical education for adults of the surrounding community, inform whether there are literacy and numeracy rates and how the project contributes to their improvement.

4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

How to measure: Inform whether the project offers workshops and lectures for the surrounding community and/or for those who work on the Project Area, presenting evidence of that.

4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.

How to measure: Inform whether the project offers schooling for the surrounding community and demonstrate whether it meets those requirements.

5. Gender equality

5.1 End all forms of discrimination against all women and girls everywhere.

How to measure: Present the number of people directly and indirectly impacted by the project, separately by gender, demonstrating the project's contribution to ending discrimination against women and girls.

5.2 Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation.

How to measure: Inform whether the project offers lectures and discussion circles for the surrounding community and/or for those who work on the Project Area, presenting evidence of that.

5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.

How to measure: Inform whether the project offers crèches or other initiatives benefiting women who carry out unpaid care work, presenting evidence of that.

5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.

How to measure: Present the number of people directly and indirectly impacted economically by the project, separately by gender, demonstrating the project's contribution to women's participation and leadership opportunities.

6. Clean water and sanitation

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

How to measure: Demonstrate how the project contributes to an improvement in water quality and to the reduction of water pollution, presenting evidence of that contribution.

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

How to measure: Inform whether the project has mechanisms to substantially increase water-use efficiency, presenting evidence of that.

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

How to measure: Demonstrate how the project contributes to the protection and restoration of ecosystems, presenting evidence of that contribution.

6.7 Support and strengthen the participation of local communities in improving water and sanitation management.

How to measure: Inform whether the project offers lectures and discussion circles for the surrounding community and/or for those who work on the Project Area, presenting evidence of that.

7. Affordable and clean energy

7.2 By 2030, substantially increase the share of renewable energy in the global energy mix.

How to measure: Demonstrate how the project contributes to creating renewable energy sources, presenting evidence of that.

8. Decent work and economic growth

8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.

How to measure: Demonstrate how the project contributes to increasing the provision of full and productive employment and decent work, presenting evidence of that.

8.6 By 2020, substantially reduce the proportion of young people not in employment, education or training.

How to measure: Demonstrate how the project contributes to the reduction of youth unemployment, presenting evidence of that.

8.7 Take immediate and effective measures to eradicate forced labor, end modern slavery and human trafficking, and secure the prohibition and elimination of the worst forms of child labor, including recruitment and use of child soldiers, and by 2025 end child labor in all its forms.

How to measure: Prove that the project does not adopt any type, directly or indirectly, of forced labor or child labor, presenting evidence of that.

8.8 Protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment.

How to measure: Prove that the project respects labor rights and promotes safe and secure working environments, presenting evidence of that.

8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.

How to measure: Demonstrate how the project contributes to promoting sustainable tourism, presenting evidence of that.

10. Reduction of inequalities

10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.

How to measure: Present the number of people directly and indirectly impacted economically by the project and demonstrate the project's contribution to income growth of the bottom 40% of the population.

10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.

How to measure: Present the number of people directly and indirectly impacted economically by the project and demonstrate the project's contribution to the inclusion of all.

10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard.

How to measure: Demonstrate that the project does not have discriminatory practices, presenting evidence of the equal treatment of all.

11. Sustainable cities and communities

11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

How to measure: Demonstrate how the project contributes to the reduction of the number of deaths and the number of people affected by disasters, presenting evidence of that.

11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

How to measure: Demonstrate how the project contributes to the reduction of the adverse per capita environmental impact of cities, presenting evidence of that.

11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, for women and children, older persons and persons with disabilities.

How to measure: Demonstrate how the project contributes to universal access to green spaces, in particular for women and children, presenting evidence of that.

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.

How to measure: Demonstrate how the project contributes to fostering positive economic, social and environmental links between urban, peri-urban and rural areas, presenting evidence of that.

12. Responsible consumption and production

12.2 By 2030, achieve the sustainable management and efficient use of natural resources.

How to measure: Demonstrate how the project contributes to the sustainable management and efficient use of natural resources, presenting evidence of that.

12.3 By 2030, halve per capita global food waste at the retail and consumer level and reduce food losses along production and supply chains, including post-harvest losses.

How to measure: Demonstrate how the project contributes to the reduction of food waste and food losses, presenting evidence of that.

12.4 By 2020, achieve the environmentally sound management of chemicals and all waste throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

How to measure: Demonstrate how the project contributes to the environmentally sound management of chemicals and waste, presenting evidence of that.

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

How to measure: Demonstrate how the project contributes to the reduction of waste generation through prevention, reduction, recycling and reuse, presenting evidence of that.

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

How to measure: Demonstrate the sustainable practices that the project adopts and how they are reported in its reports, presenting evidence of that.

12.7 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

How to measure: Inform whether the project offers workshops on those themes for the surrounding community, presenting evidence of that.

12.8 Develop and implement tools to monitor the impacts of sustainable development on sustainable tourism, which generates jobs and promotes local culture and products.

How to measure: Demonstrate how the project contributes to the implementation of tools to monitor the impacts of sustainable development, presenting evidence of that.

13. Action against global climate change

13.2 Integrate climate change measures into national policies, strategies and planning.

How to measure: Demonstrate how the project has been integrating climate change measures into policies, strategies and planning, presenting evidence of that.

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

How to measure: Inform whether the project offers workshops on those themes for the surrounding community, presenting evidence of that.

15. Life on land

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

How to measure: Demonstrate how the project has been ensuring the conservation, restoration and sustainable use of terrestrial ecosystems, presenting evidence of that.

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

How to measure: Demonstrate how the project implements sustainable forest management, halts deforestation, restores degraded forests and substantially increases afforestation and reforestation, presenting evidence of that.

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

How to measure: Demonstrate how the project contributes to combating desertification and restoring degraded land and soil, presenting evidence of that.

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits that are essential for sustainable development.

How to measure: Demonstrate whether the project contributes to the conservation of mountain ecosystems, including their biodiversity, presenting evidence of that.

15.6 Ensure fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed.

How to measure: Demonstrate that the project ensures fair and equitable sharing of the benefits arising from the utilization of genetic resources, presenting evidence of that.

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.

How to measure: Demonstrate that the project ensures fair and equitable sharing of the benefits arising from the utilization of genetic resources, presenting evidence of that.

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.

How to measure: Demonstrate that the project has been introducing measures to prevent the introduction and significantly reduce the impact of invasive alien species, presenting evidence of that.

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.

How to measure: Demonstrate that the project integrates ecosystem and biodiversity values with national and local strategies, presenting evidence of that.

16. **Peace, Justice and Effective Institutions**

16.1 Significantly reduce all forms of violence and related death rates everywhere.

How to measure: Inform whether the project offers lectures or discussion circles on violence and demonstrate how this contributes to the reduction of violence, presenting evidence of that.

16.2 End abuse, exploitation, trafficking and all forms of violence and torture against children.

How to measure: Demonstrate that the project respects childhood and does not practice abuse or child exploitation, as well as that it does not contribute to the trafficking or to forms of violence against children, presenting evidence of that.

16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.

How to measure: Demonstrate that the project offers lectures or discussion circles on fundamental freedoms, presenting evidence of that.

Annex IV. Sustainable Development Goal weights for application in Equation 34. Calculation of the SDG compliance indicator.

Sustainable Development Goals	Weight	Justification
1 – Eradication of Poverty	3	Basis of all the other SDGs. Extreme poverty prevents access to basic services, education and opportunities.
2 – Zero Hunger and Sustainable Agriculture	3	Food security is fundamental for human health and development. Sustainable agriculture contributes to food security and to the conservation of ecosystems.
3 – Health and Well-being	3	Health is a fundamental human right and a prerequisite for development.
4 – Quality Education	3	Education is the basis for the development of human and social capital. An educated population is more productive, has access to better jobs and is more engaged with civil society.
5 – Gender Equality	3	Gender equality is essential for sustainable development. Women represent half of the world's population and their empowerment is fundamental for poverty reduction and for economic and social development.
6 – Clean Water and Sanitation	3	Access to drinking water and basic sanitation is fundamental for health, food security and productivity.
7 – Affordable and Clean Energy	2	The transition to renewable energy sources is crucial to mitigate climate change and to ensure access to clean and affordable energy for all.
8 – Decent Work and Economic Growth	3	Decent work and inclusive economic growth are important for reducing poverty and promoting social development.
9 – Industry, Innovation and Infrastructure	2	Industry, innovation and infrastructure are drivers of economic growth and development.
10 – Reduction of Inequalities	3	The reduction of inequalities is fundamental for building more just and cohesive societies.
11 – Sustainable Cities and Communities	2	Cities are the future of humanity. Sustainable cities are healthier, more efficient and more resilient.
12 – Responsible Consumption and Production	2	Sustainable consumption and production are essential for reducing environmental impact and ensuring natural resources for future generations.
13 – Action Against Global Climate Change	3	Climate change represents an existential threat to humanity. Climate action is an urgent priority.
14 – Life Below Water	2	The oceans are the lungs of the planet. The protection of the oceans is essential for life on Earth.
15 – Life on Land	2	Biodiversity is fundamental for the health of ecosystems and human well-being.
16 – Peace, Justice and Effective Institutions	2	Peace, justice and effective institutions are prerequisites for sustainable development.
17 – Partnerships and Means of Implementation	1	Partnerships are essential to accelerate the implementation of the SDGs.

Annex V. Example application of the textural triangle for soil classification based on the proportions of clay, silt and sand.

Example: Where two soil samples have been collected from the Project Area, containing the following proportions of clay, silt and sand, as set out below:

- Sample A: 70% clay (or 700g clay/1000g soil), 18.2% silt (or 182 g silt/1000g soil) and 11.8% sand (or 118 g sand/1000g soil).
- Sample B: 75% clay (or 750g clay/1000g soil), 15% silt (or 150 g silt/1000g soil) and 10% sand (or 100 g sand/1000g soil).

Calculation of the mean:

$$F_{clay} = \frac{70 + 75}{2} = 72{,}35\%$$

$$F_{silt} = \frac{18{,}2 + 15}{2} = 16{,}60\%$$

$$F_{sand} = \frac{11{,}7 + 10}{2} = 11{,}05\%$$

After the calculation of the mean grain-size fractions, it is possible to determine the textural class of the soil using the Textural Triangle, which is an internationally recognized tool for the classification of soils on the basis of the proportions of clay, silt and sand. *Soil Conservation Service (SCS)* of the United States[116]

The Textural Triangle presents the proportions of clay, silt and sand, allowing the soil to be classified into the 12 textural classes established by the USDA.

Where the online calculator made available by the United States Department of Agriculture (USDA) [117], is not used, the textural definition of the soil may be carried out manually by means of the triangle. For example, for the mean sample calculated above, the sum of the proportions of clay, silt and sand must be plotted on the triangle, so as to identify the textural class of the soil.

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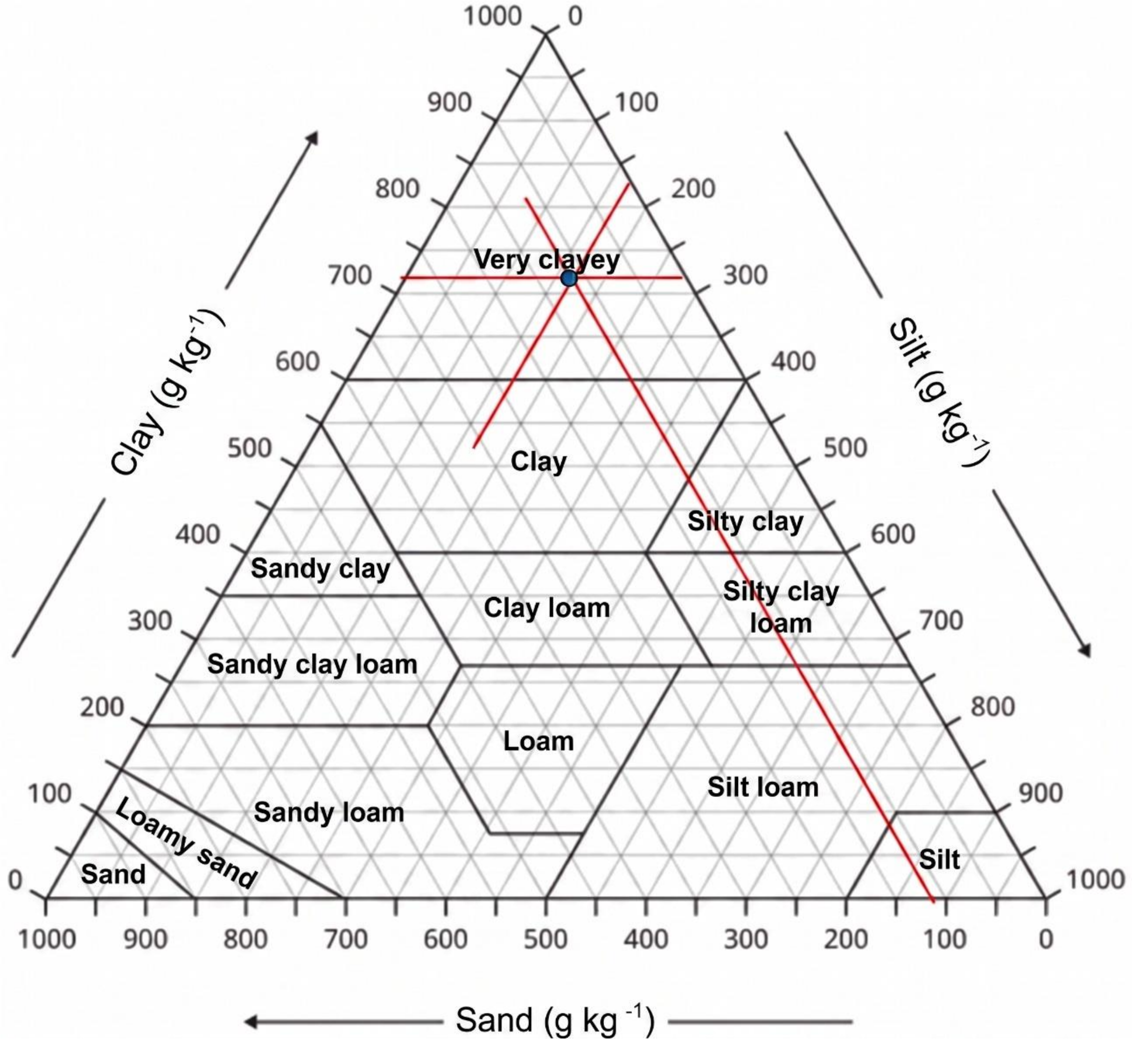
[116] Soil Survey Manual. Washington, D.C: Department of Agriculture. Soil Conservation Service, 437p. (USDA. Agriculture. Handbook, 18) 2ª ed. 1993. Disponível em: https://www.nrcs.usda.gov/sites/default/files/2022-09/The-Soil-Survey-Manual.pdf. Acesso em: 13 nov. 2025.)

[117] Available at: https://www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-texture-calculator. Accessed on: 18 Dec. 2025.

Figure 7. Example of the use of the Textural Triangle.



Source: ECCON (2025) adapted from the Brazilian Soil Classification System (2025) and De Lemos and Santos (1996)

SUPPLEMENT TO THE METHODOLOGY PSA CARBON AGRO: BASELINE AND ADDITIONALITY

Version 1.0
12 February 2026

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SUMMARY

1. Methodological basis for the calculation – PSA Carbon Agro (native vegetation and cultivation)

The calculation presented for determining the carbon stock of native vegetation present on farms with conservation and cultivation areas is based on a comparison between two distinct scenarios for measuring, maintaining and increasing the carbon stock over time: (a) **the baseline**, which results from the scenario without PSA, in which there are no intentional conservation initiatives, nor any initiatives for the measurement and improvement of production practices; and (b) **the project scenario**, that is, with the implementation of the PSA project, characterized by the adoption of intentional conservation initiatives, as well as the implementation of measurement and improvements in production practices, the adoption of which results in the maintenance and improvement of environmental services in both conservation areas and productive areas.

For quantifying the effect of PSA in the conservation scenario, losses due to climate change are considered over a 100-year time horizon. By contrast, for quantifying the effect of PSA in productive areas, without PSA there is no quantification, nor are there intentional actions to improve practices, in which credits are neither quantified nor measured. In productive areas, the generation of C+ is linked to the Mean Carbon Benefit (MCB) over the 40 years of the project, associated with good practices and the measurement thereof.

1.1. Conservation

For conservation areas, the logic of the model considers that, even in the absence of deforestation, forests are subject to a progressive loss of biomass and carbon as a result of climate change, as demonstrated by scientific studies associated with IPCC climate scenarios. In this context, the calculation is anchored in the extremes represented by scenarios RCP 2.6 ([1]optimistic) and RCP 8.5 ([2,3]pessimistic), which delimit the plausible range of future forest degradation, illustrated in the figure below.

[1] Popp, Alexander, Katherine Calvin, Shinichiro Fujimori, et al. 2017. "Land-Use Futures in the Shared Socio-Economic Pathways." *Global Environmental Change* 42 (January): 331–45. https://doi.org/10.1016/j.gloenvcha.2016.10.002.

[2] Robertson, Richard D., Alessandro De Pinto, and Nicola Cenacchi. 2023. "Assessing the Future Global Distribution of Land Ecosystems as Determined by Climate Change and Cropland Incursion." *Climatic Change* 176 (8): 108. https://doi.org/10.1007/s10584-023-03584-3.

[3] Uribe, Maria Del Rosario, Michael T. Coe, Andrea D. A. Castanho, Marcia N. Macedo, Denis Valle, and Paulo M. Brando. 2023. "Net Loss of Biomass Predicted for Tropical Biomes in a Changing Climate." Nature Climate Change 13 (3): 274–81. https://doi.org/10.1038/s41558-023-01600-z.

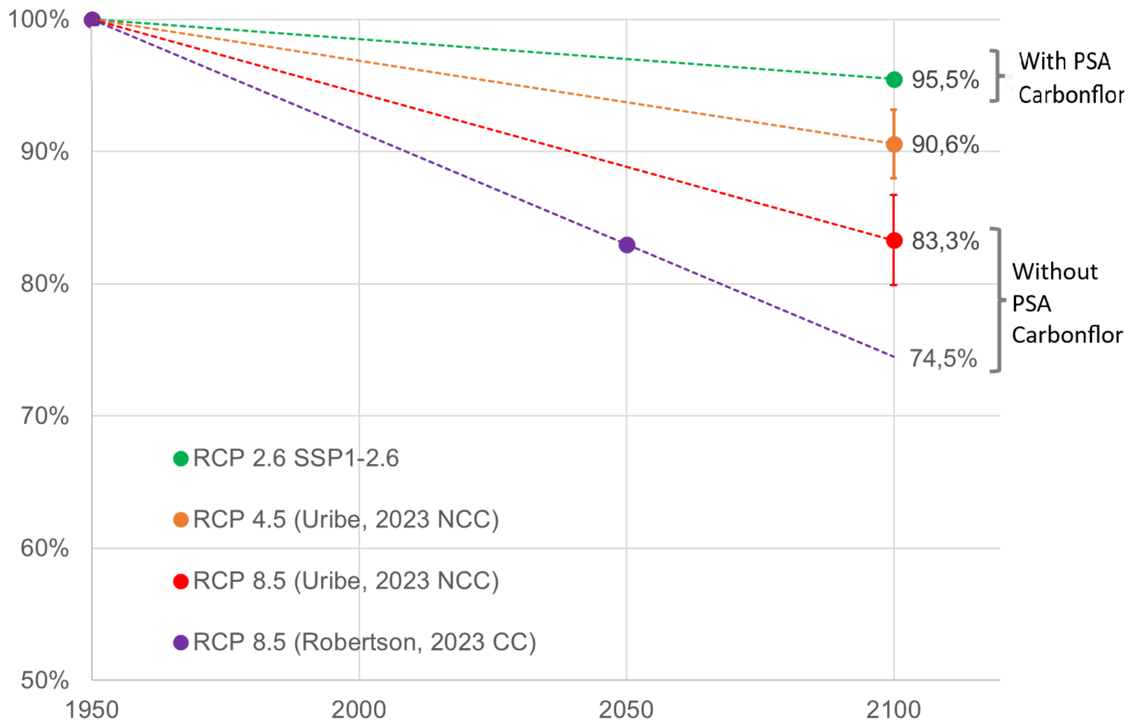

Figure 11 Scenarios of degradation and biomass loss in tropical forests and the theoretical basis of the degradation factor used in PSA Carbonflor and in the conservation component of PSA Carbon Agro.

If humanity is able to continue along SSP1-2.6, meeting the goals of the Paris Agreement, the carbon balance should not be affected so severely, with an estimated loss of approximately 5% of tropical forest biomass by the end of the century. Unfortunately, this does not appear to be a plausible scenario. The articles presented here suggest a loss of tropical forest biomass in the order of 17% to 25% by the end of the century. In other words, the effect of implementing PSA focused on conservation (Carbonflor and the native vegetation component of Carbon Agro) suggests a reduction in loss of 12% to 20%, resulting from the difference between the scenario without the project and with the project.

In this sense, conservatively, we consider the degradation factor for PSA focused on conservation (Carbonflor and the native vegetation component of Carbon Agro) to be **10%** for Brazil.

The degradation factor may be updated owing to the emergence of more realistic, or regionalized, studies and scenarios, but a project within PSA may not use a specific degradation factor if it lacks a scientific basis and if this factor is not included in the methodological basis.

1.2. Agricultural Cultivation

In the scenario without PSA Carbon Agro, the absence of incentives for the adoption of sustainable agricultural practices is assumed, which perpetuates the vicious cycle expressed by the dissociation between conservation and cultivation on a multifunctional property. Consequently, in this common case, there is neither quantification nor monitoring of agricultural practice indicators.

Therefore, even if the carbon arising from the growth of perennial crops (Sequestered Carbon and MCB) were calculated, the absence of measurement and monitoring of agricultural practices would make it impossible to construct the Agricultural Practices Matrix and, thus, multiplying the sequestered carbon by zero would result in zero generation of C+ from agricultural cultivation areas.

With the implementation of PSA Carbon Agro in cultivation areas, both the amounts of Sequestered Carbon and the MCB are quantified, as well as the Agricultural Practice Indicators, which reflect the adoption of best management practices in productive areas. The continuous quantification of the sustainable agricultural practices adopted, as well as their potential for improvement over time, makes it possible to generate C+ credits in accordance with the PSA Carbon Agro methodology, a scenario possible only with the application of the Methodology. In this sense, intentional actions to maintain and improve practices allow the quantification, measurement and generation of C+.

Thus, the difference between the two scenarios reflects the verifiable activities of measuring benefits associated with sustainable cultivation, indexed to the C+ originating in the Agricultural Cultivation Area. In this way, without PSA, the generation of C+ is zero, and with PSA, with practices duly measured, there is an outcome in the agricultural practice indicators matrix that allows the generation of C+ in its entirety.

This methodological chain ensures that PSA Carbon Agro, both in its conservation component and in its productive component, adopts a conservative approach, grounded in science and aligned with international best practice for climate integrity, enabling the generation of environmentally robust and technically consistent C+.