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METHODOLOGY FOR THE GENERATION OF VERIFIED BIODIVERSITY-BASED CREDITS THROUGH RESTORATION AND CONSERVATION ACTIONS

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I. INTRODUCTION

Biodiversity underpins the stability, functioning, and resilience of ecosystems, supporting essential services such as water regulation, soil formation, pollination, and climate regulation that are critical for human well-being and the global economy. Accelerating habitat loss, ecosystem degradation, fragmentation, and climate change are driving unprecedented declines in species and ecosystem integrity, undermining progress toward international biodiversity and climate objectives and increasing risks for local communities and productive systems. Despite growing awareness, biodiversity conservation and restoration remain chronically underfinanced, and many high-biodiversity areas—especially those outside strictly protected zones or not primarily valued for carbon—receive limited or no dedicated funding.

In this context, biodiversity credits emerge as a complementary mechanism to carbon and other environmental markets, designed to recognize and reward measurable, verifiable gains in the condition and persistence of ecosystems and species. By creating a standardized unit of biodiversity benefit, credits can mobilize new streams of finance for projects that conserve, restore, or enhance biodiversity across different land uses, including forests, agroecosystems, urban green spaces, and freshwater landscapes. To be credible and effective, however, these credits must be grounded in a robust methodological framework that quantifies biodiversity outcomes in a transparent, conservative, and scientifically sound manner.

The purpose of this Biodiversity Restoration and Conservation methodology is to provide such a framework, enabling project developers, auditors, and buyers to consistently evaluate and certify the biodiversity benefits generated by restoration and conservation activities. The methodology establishes clear rules and indicators to assess changes in biodiversity at the ecosystem, landscape, and species levels, linking those changes to a defined credit unit that can be issued, monitored, and verified over time. It applies to multiple project types—such as forest management, regenerative agriculture, urban forests, and water flow restoration—while maintaining comparability and integrity across different contexts and geographies.

Conceptually, the methodology treats biodiversity as a multidimensional attribute that encompasses species richness and diversity, habitat quality, structural complexity, connectivity, and resilience to current and future pressures, including climate change. It combines field-based inventories of flora and fauna with spatial and landscape-level analyses to evaluate preserved areas, restored areas, and the ecological condition of the broader project zone, using standardized indices and classification schemes. By integrating both present conditions and forward-looking risk factors, the methodology seeks to ensure that credited outcomes reflect not only the quantity of habitat preserved or restored, but also the quality and durability of the biodiversity it supports.

This methodology follows principles of scientific rigor, transparency, conservativeness, environmental and social integrity, and alignment with international biodiversity and climate agendas. It promotes the use of native species, discourages conversion of natural ecosystems to non-native land uses, and encourages meaningful participation of local and Indigenous communities in project design, implementation, and monitoring. Within the broader certification system, the Biodiversity Restoration and Conservation methodology provides the technical basis for project eligibility, baseline and impact quantification, and ongoing monitoring, forming the foundation for the issuance of high-quality biodiversity credits that contribute tangibly to global restoration and conservation goals.

ACRONYMS AND ABBREVIATIONS

aOCP	ases On-Chain Protocol.
aOCP-ITTE	aOCP Technical Team.
BIKPS	Biodiversity Index of Key Protected Species.
BIPA	Biodiversity Index of the Preserved Area.
BIRA	Biodiversity Index of Restored Area.
EICAT	Environmental Impact Classification for Alien Taxa.
EVCCI	Ecosystem Vulnerability to Climate Change Index.
FA	Forest area.
FDI	Fractal Dimension Index.
FI	Fragmentation Index.
IUCN	International Union for Conservation of Nature.
LecoS	Landscape Ecology Statistics (QGIS plugin).
MO	Minimal Negative Effect (harmful invasive category in EICAT).
MR	Moderate Negative Effect (harmful invasive category in EICAT).
MSA	Mean Species Abundance.
MV	Major Negative Effect (harmful invasive category in EICAT).
NPP	Net Primary Productivity.
NPP2050	Net Primary Productivity in 2050 scenario.
NPPc	Current Net Primary Productivity.
PA	Preserved area.

PSF	Project Submission Form.
QGIS	Quantum Geographic Information System (GIS software).
RA	Restored area.
RCP 4.5	Representative Concentration Pathway 4.5 (IPCC climate scenario).
SCI	Spatial Continuity Index.
SDG	Sustainable Development Goal.
SVCCI	Species Vulnerability to Climate Change Index.
TA	Total area.
UN	United Nations.
VBBC	Verified Biodiversity-Based Credit.

II. Definitions

See the definitions relevant to this document in the most recent version of the aOCP Program Definitions document.

III. Overall components

III.1 Methodology Scope

This Methodology for Biodiversity Restoration and Conservation applies to projects and activities that seek to quantify, enhance, or conserve biodiversity at the ecosystem, landscape, and species levels within a defined project area and its area of influence. The scope covers interventions in forest management, urban and peri-urban forests, regenerative agriculture, silvopastoral systems, and water flow restoration, where actions are focused on the conservation, protection, or restoration of native ecosystems and do not involve conversion to non-native land uses.

The methodology assesses changes in biodiversity conditions attributable to project activities by analyzing three core dimensions: preserved area, restored area, and ecological condition of the intervened zone. It operates these dimensions through a standardized set of parameters, including species richness and diversity indices, habitat structure and fragmentation metrics, spatial continuity, and ecosystem and species vulnerability to climate change. The assessment applies to projects initiated within the last 24 months that comply with the program's eligibility criteria, integrate local communities, and address existing or potential biodiversity degradation.

Within this scope, the methodology evaluates both flora and fauna, with emphasis on native and key (e.g., threatened or keystone) species, and explicitly considers interactions between

biodiversity, ecosystem functioning, and landscape configuration. The project area is assessed in situ and through spatial analysis at appropriate scales (e.g., micro-watershed or 1 km area of influence), using primary field data, remote sensing, and modeling tools to ensure a comprehensive and comparable characterization of biodiversity outcomes. The resulting indicators and relativized indices provide a common quantitative basis to monitor and report biodiversity performance over time and, where relevant, to support the issuance of verified biodiversity credits or equivalent performance claims.

III.2 ELIGIBLE ACTIVITIES

The identification of the project type within the list of eligible activities under the aOCP is a fundamental step for the success of a biodiversity restoration project. This classification makes it possible to clearly define the main activity, which will constitute the strategic core of the project, ensuring that the actions implemented directly address the primary obstacle limiting the conservation or recovery of the ecosystem.

The main activity must represent the most effective measure to restore the ecological integrity of the intervention area, generating measurable results in terms of biodiversity. Around this central action, additional eligible activities may be incorporated to complement and strengthen its impact, helping to mitigate identified threats and enhance the resilience of the restored system.

It is essential that all eligible activities, both the main and complementary ones, are aligned with the certification guidelines of the standard, in accordance with the provisions set out in Tables XXX and XXX, ensuring methodological coherence, traceability, and verifiability of results.

I.2.1. Main Restoration Activity

The main activity must:

- Directly address the predominant degradation factor (e.g., deforestation, fragmentation, loss of vegetation cover, hydrological alteration, soil compaction, overgrazing, etc.).
- Represent the most effective and technically justified measure to restore key ecological processes.
- Generate measurable results in terms of:
  - Recovery of vegetation structure
  - Increase in species diversity
  - Improvement of ecological connectivity
  - Restoration of ecosystem functions

The main eligible activities within the framework of the aOCP are presented in Table 1:

TABLE 1. MAIN ELIGIBLE ACTIVITIES

Component	Code	Eligible Activities
Ecosystem Restoration	RE.1	Reforestation with native species
	RE.2	Restoration of riparian habitats
	RE.3	Recovery of submerged seagrass meadows
	RE.4	Control of invasive species in critical ecosystems
	RE.5	Revegetation of eroded soils through revegetation
	RE.6	Rehabilitation of degraded mangroves
	RE.7	Restoration of coastal dunes
	RE.8	Wetland restoration to enhance biodiversity
	RE.9	Rehabilitation of native grasslands
	RE.10	Restoration of degraded forests

I.2.2. Eligible Complementary Activities

Additional activities may be considered eligible if they:

- Directly support the effectiveness of the main activity.
- Mitigate secondary threats that could compromise the restoration process.
- Enhance the ecological resilience of the restored system.

These activities must be justified as consistent with the restoration strategy and demonstrate their contribution to verifiable results. The eligible complementary activities within the framework of the aOCP are presented in Table 2:

TABLE 2. ELIGIBLE COMPLEMENTARY ACTIVITIES

Component	Code	Eligible Activities
Creation of artificial habitats	HA.1	Installation of bird nests
	HA.2	Biodiversity boxes for pollinating insects
	HA.3	Construction of shelters for amphibians
	HA.4	Installation of bat boxes
	HA.5	Construction of hibernacula for reptiles

Component	Code	Eligible Activities
	HA.6	Installation of artificial burrows for small mammals
	HA.7	Design of artificial ponds for amphibians and reptiles
	HA.8	Installation of floating platforms for waterbirds
	HA.9	Creation of underwater refuges for fish and crustaceans
	HA.10	Construction of artificial coral structures
Habitat management	MH.1	Creation of microhabitats with deadwood
	MH.2	Conservation of rocks and natural cavities
	MH.3	Establishment of biological corridors
	MH.4	Vegetation management to maintain open habitats
	MH.5	Structural diversification of forests
	MH.6	Grazing management to reduce soil compaction
	MH.7	Creation of temporary ponds for amphibians
	MH.8	Installation of dense shrubs for ground bird refuge
	MH.9	Preservation of vegetative islands in agricultural landscapes
	MH.10	Protection of slopes with native vegetation
	MH.11	Establishment of exclusion zones for human activities in vulnerable areas
Monitoring and control	MC.1	Monitoring of key species
	MC.2	Use of camera traps to record wildlife
	MC.3	Installation of acoustic sensors for bats and birds
	MC.4	Monitoring programs for pollinators
	MC.5	Species density studies using drones
	MC.6	Control of invasive and exotic species as well as introduced predators
	MC.7	Prevention and management of forest fires
	MC.8	Water quality monitoring in wetlands
	MC.9	Detection and protection of nesting sites
	MC.10	Erosion control in critical habitat areas
	IB.1	Construction of wildlife crossings on roads

Component	Code	Eligible Activities
Biodiversity infrastructure	IB.2	Installation of wildlife-friendly fencing
	IB.3	Creation of fish migration channels
	IB.4	Construction of bird shelters in urban areas
	IB.5	Installation of green walls for biodiversity in buildings
	IB.6	Creation of pollinator gardens in urban areas
	IB.7	Design of green roofs with native plants
	IB.8	Construction of vegetated embankments along riverbanks
	IB.9	Adaptation of bridges with green zones for terrestrial fauna
	IB.10	Installation of shaded areas in open fields
Regenerative agriculture and management	AR.1	Use of cover crops to promote insect habitats
	AR.2	Planting of living hedgerows between crops
	AR.3	Installation of wildflower strips for pollinators
	AR.4	Management of agricultural field edges for wildlife
	AR.5	Creation of wildlife-friendly crop rotations
	AR.6	Agriculture without harmful chemicals for biodiversity
	AR.7	Design of biodiverse agroforestry systems
	AR.8	Implementation of rotational grazing for bird habitats
	AR.9	Promotion of native crops in agricultural landscapes
	AR.10	Conservation of water bodies on agricultural farms
Forestry and regenerative agriculture	SR.1	Incorporation of perennial crops
	SR.2	Implementation of agroforestry systems
	SR.3	Use of polycultures
	SR.4	Large-scale composting
	SR.5	Integration of trees in agricultural landscapes
	SR.6	Promotion of legume crops
	SR.7	No-till agriculture
	SR.8	Use of green manure

Component	Code	Eligible Activities
	SR.9	Planting of drought-tolerant crops
	SR.10	Promotion of biodiversity on farms
	SR.11	Rehabilitation of ancient agricultural terraces
	SR.12	Promotion of native and resilient seeds
	SR.13	Certified organic agriculture
	SR.14	Chemical-free farming systems
	SR.15	Promotion of agroecological production
	SR.16	Use of crop rotation systems
	SR.17	Incorporation of conservation zones on farms
	SR.18	Sustainable management of aquatic agroecosystems
	SR.19	Use of regenerative practices in commercial crops
Preservation of species and habitats	PE.1	Protection of endangered nesting areas
	PE.2	Conservation of primary forests
	PE.3	Fencing and protection of areas
	PE.4	Protection of critical wetlands
	PE.5	Creation of reserves for endemic species
	PE.6	Restoration of key areas for migratory species
	PE.7	Protection of fish spawning areas
	PE.8	Conservation of caves for bats
	PE.9	Rescue and relocation of endangered species
	PE.10	Monitoring of migratory routes for wildlife
	PE.11	Preservation of habitats in islands or patches within mosaics at different ecological scales (micro, meso, macro)
	PE.12	Conservation of deadwood and nesting areas
Education and community participation	PC.1	Training in community monitoring
	PC.2	Educational programs on biodiversity
	PC.3	Creation of conservation demonstration areas

Component	Code	Eligible Activities
	PC.4	Promotion of responsible ecotourism
	PC.5	Development of community restoration programs
	PC.6	Participatory monitoring of endangered species
	PC.7	Installation of community native plant nurseries
	PC.8	Awareness on local habitat management
	PC.9	Implementation of ecological surveillance programs
	PC.10	Creation of incentives for local conservation
Faunal group-specific actions	GF.1	Restoration of habitats for migratory birds
	GF.2	Conservation of pollinating bat colonies
	GF.3	Creation of nesting sites for sea turtles
	GF.4	Construction of shelters for bees and pollinators
	GF.5	Installation of feeding areas for wildlife
	GF.6	Restoration of natural rodent burrows
	GF.7	Protection of reptile hibernation sites
	GF.8	Creation of ponds for wildlife
	GF.9	Creation of protected areas for key carnivores
Landscape protection and management	MP.1	Creation of habitat mosaics
	MP.2	Conservation of riverbanks
	MP.3	Establishment of buffer zones to protect aquatic biodiversity
	MP.4	Implementation of multifunctional landscapes: integrating agriculture, forests and natural habitats to maximize ecological benefits

III.3 Applicability and Relationship to Other aOCP Methodologies

III.3.1 Applicability conditions

This methodology applies to projects that aim to conserve, protect, restore or sustainably manage terrestrial or aquatic ecosystems, where biodiversity outcomes are primarily expressed at the ecosystem and landscape level (e.g. species richness, community composition, habitat configuration and ecological condition), rather than exclusively through a single focal species.

Eligible project types include, but are not limited to, forest management, silvopastoral systems, regenerative agriculture, urban forests and water flow restoration, provided that the project is implemented within the aOCP Program and follows its standard procedures.

A project is eligible to use this methodology when all the following conditions apply:

- a) The project implements at least one eligible conservation, protection or restoration activity consistent with the aOCP Standard and does not involve conversion of native ecosystems to non-native land uses (e.g. forest-to-agriculture conversion).
- b) The project start date is within the maximum retroactive period allowed by the aOCP Program for the issuance of biodiversity credits, and the activities generate measurable ecological benefits beyond the baseline (ecological additionality).
- c) The project area was not deforested 24 months prior to the start date; however, areas that were recently burned by wildfires or other uncontrolled fires not caused or facilitated by the project proponent or related parties remain eligible, provided that: (i) the proponent demonstrates, through independent or verifiable evidence, that the fire was not intentionally set or negligently caused to create eligibility or increase credit issuance; and (ii) in cases of recent degradation, including fire damage, the proponent demonstrates with technical evidence that urgent ecological restoration is required due to vulnerability of biodiversity and ecosystem services, and that project activities are designed to enhance ecosystem resilience to future fire and climate-related disturbances.
- d) The biodiversity of the project area is demonstrably degraded or vulnerable to degradation, fragmentation or climate-related impacts if no project activities are implemented, as evidenced by field data, remote-sensing indicators and, where available, regional assessments.

Projects that satisfy these conditions may apply the biodiversity-assessment methodology as the primary tool to quantify ecosystem-level benefits and generate Verified Biodiversity Credits based on preserved and restored areas and on improvements or maintenance of ecological condition, according to the parameters and equations described in subsequent sections.

III.3.2 Relationship with other aOCP methodologies

Use this methodology as the primary option for projects whose main objective is to conserve or restore ecosystems and landscape functions, without focusing exclusively on a single target species, and where increase in community-level indices (e.g. Shannon index), habitat structure, fragmentation and climate-resilience indicators generate biodiversity benefits.

Where a project area also hosts one or more target species that meet the criteria defined in the aOCP Methodology for Verified Biodiversity Credits by Species Conservation (e.g. threatened, endemic or keystone species), and the integrity of the habitat for these species is high (e.g. Mean Species Abundance, MSA, equal to or greater than the threshold defined in the species-

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conservation methodology), the proponent shall apply the species-conservation methodology as the primary approach for quantifying species-level conservation benefits. In such cases, this biodiversity-assessment methodology may be applied in a complementary manner to account for broader ecosystem and landscape benefits, avoiding double counting of areas and outcomes.

If a project initially applies this methodology and subsequently identifies a qualifying target species and confirms that the habitat integrity for that species meets the eligibility criteria of the species-conservation methodology (including the >0.8 MSA threshold), the project proponent shall update the methodological approach and, where appropriate, migrate part or all of the accounting for that area to the species-conservation methodology for future crediting periods. Conversely, projects implemented in more degraded or fragmented landscapes, where habitat integrity does not meet the species-conservation eligibility thresholds or where no qualifying target species is present, shall use this biodiversity-assessment methodology as the sole basis for credit generation.

The Project Submission Form must describe the selection and combination of methodologies, including: (i) justification of the chosen primary methodology; (ii) any complementary use of other aOCP methodologies; and (iii) the procedures adopted to prevent double counting of areas, indicators and credits across methodologies.

III.4 Land Eligibility

Eligibility requires both an adequate baseline of biodiversity integrity—such as a Mean Species Abundance (MSA) greater than 0.80—and active community engagement (when relevant). While specific areas targeted for conservation or restoration may fall below the threshold, the overall project must maintain integrity above this level.

The project area must not have experienced degradation, deforestation, or fires in the 24 months prior to the start of the project attributable to the landowners or inhabitants. The project developer must demonstrate it through historical remote sense images.

In exceptional cases where there is recent degradation, the project developer must present:

- Technical evidence documenting the state of vulnerability of biodiversity and ecosystem services.
- Analysis of the causes of degradation and its impact on ecosystem functionality.
- Justification of the immediate need for intervention to prevent irreversible losses.
- Detailed plan of the proposed restoration actions.

IV. Project Requirements

IV.1 Additionality

Projects must comply with the aOCP additionality rules.

IV.2 Right of Use

The project developer must provide evidence of the rights of use of the project area for carbon removals and biodiversity credits certifications (and, optionally, for soil and water credits, as appropriate) throughout the project lifetime. If the project developer is the landowner, it must provide a copy of the title deed. If the project developer is not the landowner, proceed by signing a contract with the landowner, usufruct contracts, government concessions, or formalized community agreements, as applicable.

IV.3 Law compliance

Projects must comply with all applicable environmental regulations, including restoration permits, environmental impact studies and land use change authorizations when required. The project proponent must present a legal compliance check, which includes a list of relevant laws, along with a brief description of their relevance to the project and a brief analysis of the project's compliance. The legal compliance check must also analyze how the project is aligned with national wetland conservation policies and international commitments on climate change.

IV.4 Project duration

As stipulated in the Permanence, Additionality, and Avoidance of Double Counting Standard, aOCP establishes a minimum project duration of 40 years to ensure permanence. This permanence will be guaranteed by a contract of the same duration signed with aOCP.

IV.5 Crediting period

40 years. The crediting period is equivalent to the project lifespan defined by aOCP (aOCP Protocol Project Standard V.2.1).

IV.6 Retroactivity

Up to five years before the date of the initial submission of the Project Submission form (PSF) and accompanying documentation, according to the aOCP Project Standard V.2.1. The project must provide evidence of previous effective action to conserve and restore mangroves in the proposed project area during the intended retroactivity period.

IV.7 Project Boundaries

The project developer must provide the following spatial information:

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- A general polygon (in .shp format) corresponding to the total area over which the developer proves legal rights for biodiversity credits certifications (and, optionally, for carbon, soil and water credits, as appropriate). This polygon constitutes the maximum limit within which the project activities can be implemented.
- Operational sub-polygons (also in .shp format) responding to the different planned activities and the ecological characteristics of the site.
- A shape file with the required stratifications:
  - Baseline preservation area with corresponding strata (e.g., different land covers and forest or ecosystem types).
  - Baseline restoration area with corresponding strata (e.g., different land covers and forest or ecosystem types to be restored).
  - Shapefile(s) with other spatialized environmental relevant information (hydrological regime, soil types, etc.).

The aOCP-ITTE carries out the final technical validation of all spatial documentation submitted and maintain an updated digital record of project information.

IV.8 Reporting

The aOCP-ITTE prepares the monitoring reports, following a standardized format that includes:

- Detailed documentation of the methods, models, and parameters used in carbon estimates.
- Detailed description of the methods and statistical analysis used to process and analyze the data collected.
- Evaluation of the obtained results and their relationship with the implemented interventions.
- An assessment of significant changes in site conditions or project implementation that could affect biodiversity estimates.
- Technical Recommendations for optimizing results, including areas requiring special attention and propose adjustments to monitoring strategies or restoration interventions where necessary.

The project must maintain detailed records including:

- Complete forest inventories.
- Initial establishment data.
- Records of management interventions.

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IV.9 Other design and implementation elements

In addition to the above requirements, the project must also consider the following elements:

- a) Ensure that the vegetation established, managed or restored within the project boundary is composed predominantly by native species appropriate to the local ecosystem, while allowing the temporary use of non-invasive exotic species strictly as nurse or facilitation species, provided that: (i) their role, spatial arrangement and management are explicitly designed to accelerate the recovery of native ecological communities; (ii) project documentation includes a clear, time-bound plan and silvicultural regime for their progressive removal or replacement by native species so that, at project maturity, the target ecosystem is dominated by native species; and (iii) such exotic nurse species are not counted as positive contributions in biodiversity baselines, monitoring, or crediting calculations, and are subject to control measures to prevent naturalization or invasive behavior.
- b) Meaningful involve local communities and/or Indigenous Peoples located within the project area or who may be directly affected by the project's implementation in its design and execution, in line with the social and ecosystem safeguards of the aOCP Standard.
- c) Verify that no invasive species in the project area are classified as harmful (MV, MR, and MO) according to the IUCN's Environmental Impact Classification for Alien Taxa[1] (EICAT) or in national lists of invasive species. If such species occur in the project area, include strategies to remove or manage them.

IV.10 Data Management

The aOCP-ITTE oversees project data management, which includes:

Field data. The aOCP-ITTE maintains a structured recording system that documents all field measurements. This system includes standardized formats for data collection, georeferenced photographic records, and notes on conditions observed during sampling.

Data Management and Storage. A comprehensive data management system is implemented to ensure the traceability and security of all information generated by the project. This system includes protocols for regular data backup, document version control, and verification procedures for data entry.

The aOCP-ITTE keeps all documentation related to quality assurance and control up to date and available for review during technical audits conducted.

[1] https://portals.iucn.org/library/sites/library/files/documents/2020-026-En.pdf.

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IV.11 Quality assurance and Quality control

Quality assurance and control comprise the following elements:

IV.11.1 Field Quality Assurance

The aOCP-ITTE implements a rigorous quality assurance system for field activities focused on:

1. **Standardized training of technical staff in measurement and data recording protocols**. This training includes practical measurement exercises to ensure consistency between different technicians.
2. **Verification of the condition, operation and proper use of basic measuring instruments** such as measuring tapes, measuring rods and GPS. The aOCP-ITTE carries out this verification before each field campaign to ensure reliable measurements.
3. **Direct supervision of sampling campaigns by experienced aOCP-ITTE staff**, who verify the correct application of protocols, and the quality of the data collected.

IV.11.2 Data Validation and Modelling

Data generated by remote sensing and modelling are subjected to a systematic validation process. This process includes checking the quality of the satellite images used, assessing the accuracy of the Random Forest model, and comparing results with independent field measurements. The aOCP-ITTE maintains detailed records of all validation procedures, including model performance metrics and adjustments made to improve the accuracy of estimates.

IV.12 Other Required Contributions

Projects applying to Verified Biodiversity-based Credits (VBBCs) using this methodology can also contribute to the elements presented in the following sections.

IV.12.1 Carbon and Other Environmental Services

Project proponents can also apply for one of the aOCP carbon, soil, or water related methodologies and certify these types of credits.

IV.12.2 Environment and Society

The aOCP requires Project Proponents to demonstrate that their Project Activity does not adversely affect the environment and society in any way, while contributing to the mitigation of climate change and improving biodiversity.

Project Proponents can demonstrate this accomplishment by following the Environment and Social Safeguards Standard.

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IV.12.3 Sustainable Development Goals

The aOCP Program offers Project Proponents the chance to voluntarily demonstrate that their Project Activity helps to achieve the United Nations Sustainable Development Goals (SDGs). The impact of projects' contributions to the UN SDGs are also considered, either through the use of an external tool or a similar methodology proposed by the project proponent that helps to clearly identify and quantify Projects' contribution to the achievement of UN SDGs.

The tool is used to evaluate the project's contribution to the SDGs during both project validation and project activities verification.

V. METHODOLOGICAL REQUIREMENTS

This methodology prescribes two complementary types of assessments: the baseline and the periodic monitoring evaluations. The baseline assessment provides a comprehensive initial measurement of biodiversity in the project area, quantifying preserved and restored areas and the ecological condition factors that feed into the biodiversity credit equation; these results become the reference values that must not be degraded over the project lifetime. Periodic monitoring assessments, carried out according to the project's Monitoring Plan, apply the same indicators and calculation procedures to track changes over time, verify that the baseline conditions are maintained or improved, and support the issuance of biodiversity credits throughout the 10-year crediting period.

The proposed method for calculating the benefits of the project to biodiversity is based on three main variables: preserved area, restored area, and ecological conditions of the intervened area. This holistic approach recognizes that biodiversity is a complex system and that its conservation requires consideration of multiple dimensions: species diversity, ecosystem, landscape structure and function, and long-term evaluation.

All the considered variables are relativized using a relativization function to assign a common scale between 0 and 1, as shown in Eq. 1.

$$RV = \frac{X - X_{min}}{X_{Max} - X_{min}} \qquad \text{Eq. 1}$$

Where:

RV	Relativized variable value.
X	Observed value.
X_max	Maximum observed value.

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X_min Minimum observed value.

V.1 SELECTION OF AREAS FOR RESTORATION AND PRESERVATION

This methodology recognizes two distinct types of biodiversity benefit: maintaining existing ecosystems in good condition and creating or improving habitat through active restoration, and each is accounted for differently in the crediting equation, as explained below. Preserved areas are those within the project boundary that remain under protection without conversion, while restored areas are explicitly defined as the areas where project restoration activities have been implemented, primarily through reforestation or planting of native vegetation, whose species composition and diversity are then quantified using the Shannon index based on the number of individuals planted. This distinction ensures that credits reflect both the value of avoiding further loss and the additional gains generated by restoration interventions and prevents double counting by clearly attributing each square meter either to conservation or to restoration within the credit calculation.

V.2 VERIFIED BIODIVERSITY-BASED CREDITS AND BASELINE SCENARIO

The baseline scenario establishes the reference biodiversity condition of the project area prior to, or at the start of, project implementation, against which all future changes will be evaluated. It is determined through a one-time assessment of the preserved area, any existing restored area, and the ecological condition of the intervened zone, using the biodiversity and landscape indicators defined in this methodology. Applying Equation 1 to baseline data yields the Baseline Biodiversity Index, which serves solely as a reference value for subsequent monitoring and crediting and does not in itself generate Verified Biodiversity Credits. Applying the same equation to the monitoring data of any monitoring period yields the Verified Biodiversity-Based Credits (VBBCs).

$$VBCC = \frac{TA \times BIKPS + FI + FDI + SCI + EVCCI) + RA \times BIRA + PA \times BIPA}{100} \quad \text{Eq. 2}$$

Where:

VBBC Verified Biodiversity-Based Credits (or **Baseline Biodiversity Index**, if applied to the baseline data).

TA Total area (m2).

BIKPS Biodiversity Index of Key Protected Species.

FI Fragmentation Index.

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FDI	Fractal Dimension Index.
SCI	Spatial Continuity Index.
EVCCI	Ecosystem Vulnerability to Climate Change Index.
SVCCI	Species Vulnerability to climate change.
RA	Restored area (m2).
BIRA	Biodiversity Index of Restored Area.
PA	Preserved area (m2).
BIPA	Biodiversity Index of the Preserved Area.

V.2.1 Methodological Parameters

The following sections describe each of the variables required for the calculation of Eq. 2 and their calculation procedures. Eq. 2 must be calculated for each monitoring period (i.e., yearly).

V.2.1.1 Biodiversity Index of Key Protected Species (BIKPS)

From the full flora and fauna inventory (direct counts and bioacoustic records), select only those species that are listed as protected on the IUCN Red List, and listed in your country's protection regulations. These selected taxa are treated as "key species" for the BIKPS factor

The "Biodiversity index of key protected species" in the aOCP methodology is simply the Shannon–Wiener diversity index calculated only for the subset of species that are legally or internationally protected, using their relative abundances, as shown in Eq. 3:

$$\boldsymbol{BIKPS} = -\sum_{\boldsymbol{i=1}}^{\boldsymbol{S}} \boldsymbol{p_i} \times \boldsymbol{Ln}(\boldsymbol{p_i}) \qquad \text{Eq. 3}$$

Where:

BIKPS	Biodiversity index of key protected species (Shannon-Wiener Index).
S	Number of key protected species.
pi	Relative abundance of species i in the species collection.

pi is calculated as number of individuals of species i divided by total individuals of all key species.

If only part of the area is sampled, biodiversity is expressed according to the following equation:

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$$BIKPS = \sum_{i=1}^{S} \left(\frac{n_i}{n} \times ln \frac{n_i}{n}\right)$$ Eq. 4

Were:

BIKPS	Biodiversity index of key protected species (Shannon-Wiener Index).
S	Total number of sampled species.
ni	Abundance of species i.
n	Abundance of all species/categories of the sample.

The calculated BIKPS is then interpreted/relativized according to **Erreur ! Source du renvoi introuvable.**

TABLE 3. RELATIVIZATION OF THE BIKPS

Classification	BIKPS value	Relativized BIKPS
Very low	< 1.02	0.01
Low	1.03 - 1.53	0.14
Medium	1.54 - 2.11	0.32
High	2.12 - 2.65	0.67
Very high	> 2.65	1.00

V.2.1.2 Fragmentation Index (FI)

Fragmentation refers to the process by which large, contiguous habitats are divided into smaller and more isolated patches, often as a result of anthropogenic activities such as urbanization, agriculture, and infrastructure development. This process disrupts the continuity of natural landscapes, leading to adverse effects on biodiversity, ecosystem services, and ecological processes. Assessing fragmentation involves evaluating changes in landscape structure over time, identifying patterns of habitat loss and isolation, and understanding their ecological implications.

In the context of forest fragmentation, it is essential to consider the primary aspect of forest pattern, which is the total forest area. All other aspects of the pattern (e.g., patch shape, connectivity) are inherently constrained by total forest area and therefore cannot be fully interpreted without also quantifying forest extent. It is also crucial to recognize that forest fragmentation depends on both spatial scale and the observer's perspective. There is no single

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non-arbitrary scale or observer. Consequently, fragmentation must be reported across multiple scales, enabling different stakeholders to make informed decisions based on scales and thresholds relevant to their specific concerns.

The fragmentation methodology described in this document was developed by the Joint Research Centre of the European Commission (Bioeconomy Unit) and applies map analysis techniques to quantify and characterize forest fragmentation and its temporal dynamics. The fragmentation analysis is conducted in two distinct formats:

a) **Multi-Scale Analysis:** This involves a concurrent analysis across five predefined observation scales, complemented by a multi-scale summary to provide a comprehensive overview across scales.
b) **Single-Scale Analysis:** This allows fragmentation to be assessed at a user-defined Fixed Observation Scale (FOS), offering flexibility according to specific research needs.

The aOCP methodology adopts the multi-scale assessment approach due to its ability to capture fragmentation patterns across different spatial scales, providing a more nuanced understanding of ecological impacts. This approach ensures that both small-scale and large-scale fragmentation processes are considered, enabling a more robust and comprehensive analysis.

The multi-scale assessment framework quantifies the spatial density of forest cover, referred to as Forest Area Density (FAD), across five fixed observation scales using a moving window analysis with square neighborhood areas of 7, 13, 27, 81, and 243 pixels in length. Fragmentation maps are generated at each of these scales and subsequently aggregated into a summary map displaying the average FAD value across the five scales, color-coded according to the corresponding fragmentation class. The resulting fragmentation maps represent FAD values across the full range from 0% to 100%, grouped and color-coded into five fragmentation classes, as described in Figure 4. Additionally, for each of the five observation scales, the proportion of forest pixels within each fragmentation class is calculated and displayed in a bar chart, illustrating how forest fragmentation varies across scales. In this framework, the observation scales are labeled 1, 2, 3, 4, and 5, corresponding to window lengths of 7, 13, 27, 81, and 243 pixels, respectively.

TABLE 4. MULTI-SCALE FRAGMENTATION SUMMARY FAD/FAD-APP

Foreground Cover	Foreground Area Density (FAD)	Connectivity	Degree of Fragmentation
Rare	0% ≤ x < 10%	Very Low	Very High
Irregular	10% ≤ x < 40%	Low	High
Transition	40% ≤ x < 60%	Intermediate	Intermediate
Dominant	60% ≤ x < 90%	High	Low

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Intact	90% ≤ x ≤ 100%	Very High	Very Low

V.2.1.3 Fractal Dimension Index (FDI)

This index measures the complexity of shapes, its value lies between 1 and 2, where values closer to 1 correspond to the most regular perimeters, while values closer to 2 correspond to very complex shapes.

The fractal dimension index is calculated with the Landscape Ecology Statistics (LecoS) plugin of QGIS, which uses as input the forest area at the micro basin scale or area of influence (as applicable) in raster format.

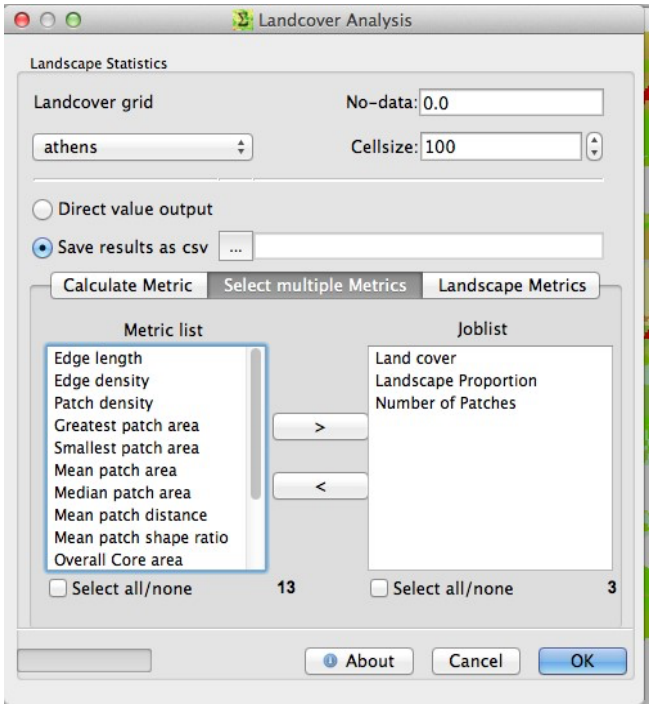

FIGURE 1. THE LANDSCAPE ECOLOGY STATISTICS (LECOS) QGIS PLUGIN

The obtained FDI is then interpreted and relativized according to Table 5.

TABLE 5. RELATIVIZATION OF THE FRACTAL DIMENSION INDEX.

Classification	FDI value	Relativized FDI
Round	< 1.25	1.00
Oval-round	1.26 - 1.50	0.68
Oval oblong	1.51 - 1.75	0.34

Classification	FDI value	Relativized FDI
Rectangular	1.76 - 1.99	0.26
Amorphous or irregular	>2	0.16

V.2.1.4 Spatial Continuity Index (SCI)

Spatial connectivity is essential for maintaining biodiversity. It enables species to move, forage, reproduce, and colonize new habitats, thereby contributing to population persistence and overall ecosystem health. Connectivity also facilitates the flow of key ecological processes such as pollination, seed dispersal, and the water cycle, supporting the provision of ecosystem services including food production, climate regulation, and water purification.

The division of natural habitats into smaller, isolated fragments reduces connectivity and restricts species movement. Therefore, to assess spatial connectivity within the project area, the results of the methodology developed by the Joint Research Centre of the European Commission (Bioeconomy Unit), will be used, as fragmentation and spatial connectivity maintain a directly inverse relationship. Higher fragmentation results in lower connectivity, since ecosystem division reduces the ability of organisms to move freely between different areas. Accordingly, the level of spatial connectivity in each project will be determined using the Forest Area Density (FAD) value and categorized according to the following thresholds:

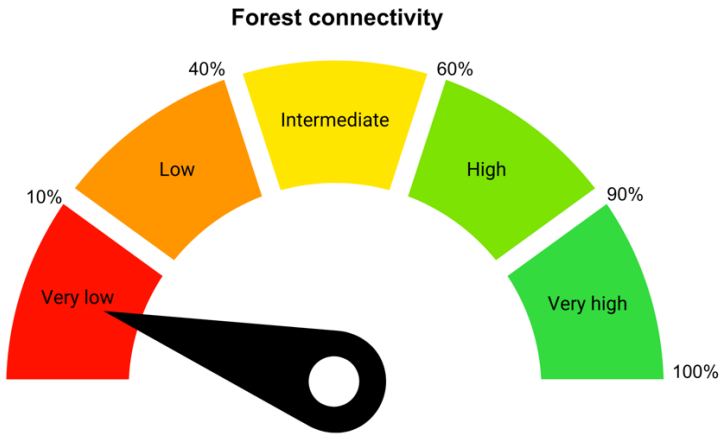

FIGURE 2. SUMMARY OF MULTISCALE FRAGMENTATION FAD/FAD-APP: CLASS THRESHOLDS, NAMES, AND COLOR ASSIGNMENTS

V.2.1.5 Ecosystem Vulnerability to Climate Change Index (EVCCI)

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Ecosystem Vulnerability to Climate Change is a highly relevant factor to consider, and its evaluation will be carried out using biomass data as a fundamental element to sustain species diversity in ecosystems, as its reduction could lead to a decrease in habitats and resources available for species, which would have a direct impact on biodiversity. The Ecosystem Vulnerability to Climate Change Index is calculated as:

$$EVCCI = TA \times NPP_c - NPP_{2050} \quad \text{Eq. 5}$$

Where:

EVCCI	Ecosystem vulnerability to climate change index.
TA	Total project area (m2).
NPP_c	Current net primary productivity (kg).
NPP_2050	Net primary productivity in 2050 climate change scenario (kg).

Net Primary Productivity (NPP) is estimated based on both average annual precipitation and average annual temperature, both for the current date and estimated for 2050. The 2050 NPP for year 2050 is calculated using the IPCC modeling inputs (RCP 45).

In both cases, the equations to be used are:

$$NPP_T = \frac{3000}{(1 + exp(1.3515 - 0.119 \times T)} \quad \text{Eq. 6}$$

$$NPP_P = 3000(1 + exp(-0.000664 \times P) \quad \text{Eq. 7}$$

Where:

NPP	Net primary productivity (kg).
T	Average annual temperature (°C).
P	Average annual precipitation (mm).

The minimum of these two values, calculated both for the current date and for 2050, is chosen for the calculation of Eq. 5.

The EVCCI calculated in Eq. 5 is then interpreted and relativized according to Table 6.

TABLE 6. RELATIVIZATION OF THE ECOSYSTEM VULNERABILITY TO CLIMATE CHANGE INDEX.

Classification	EVCCI value	Relativized EVCCI
Very low	0 - 1	1.00

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Low	1 - 3	0.67
Medium	4 - 6	0.33
High	7 - 10	0.16
Very high	> 10	0.11

V.2.1.6 Species Vulnerability to Climate Change

The vulnerability to climate change of the reforested species should be evaluated based on the current and future potential distribution models (2050 RCP 4.5) of each planted species, using the Climpact Data Science tool (https://www.cdstoolbox.shop) with the objective of determining the percentage of conditions that the project area currently presents with respect to ecological (temperature, precipitation, etc.), physical (altitude) and biological (vegetation) needs, compared to the percentage of conditions that they will find under the climate change scenario in the year 2050.

Climpact is an integrated model that allows the evaluation of optimal zones for the distribution and presence of species in a current and future time horizon. The Climpact tool takes as its main input physical, environmental and biological parameters related to species and their distribution, making it possible to identify spatially over a given territory, the potential optimal zones in which a species or a community of species could grow and survive.

Thus, Climpact Data Toolbox is based on the theory of ecological niches, which are considered as "the position of a species within an ecosystem, describing both the range of conditions necessary for the species' persistence and its ecological role in the ecosystem" (Polechonvá and Storch, 2019). Habitat is considered the physical space where a species finds food, mating sites, and shelter (Mitchell and Power, 2002). A source habitat occurs when environmental conditions are sufficient to satisfy the needs of organisms, which paves the way for the concept of ecological field (Farina and Belgrano, 2004).

Climatic variables acquire significant relevance since they greatly influence the survival and adaptation of species, especially in areas where climatic gradients are significant. This also provides a description of the climatic envelope of each species and can also be considered a limiting factor (Woodward, 1987). The following diagram schematizes the first step of the Climpact Data Toolbox process (calibration):

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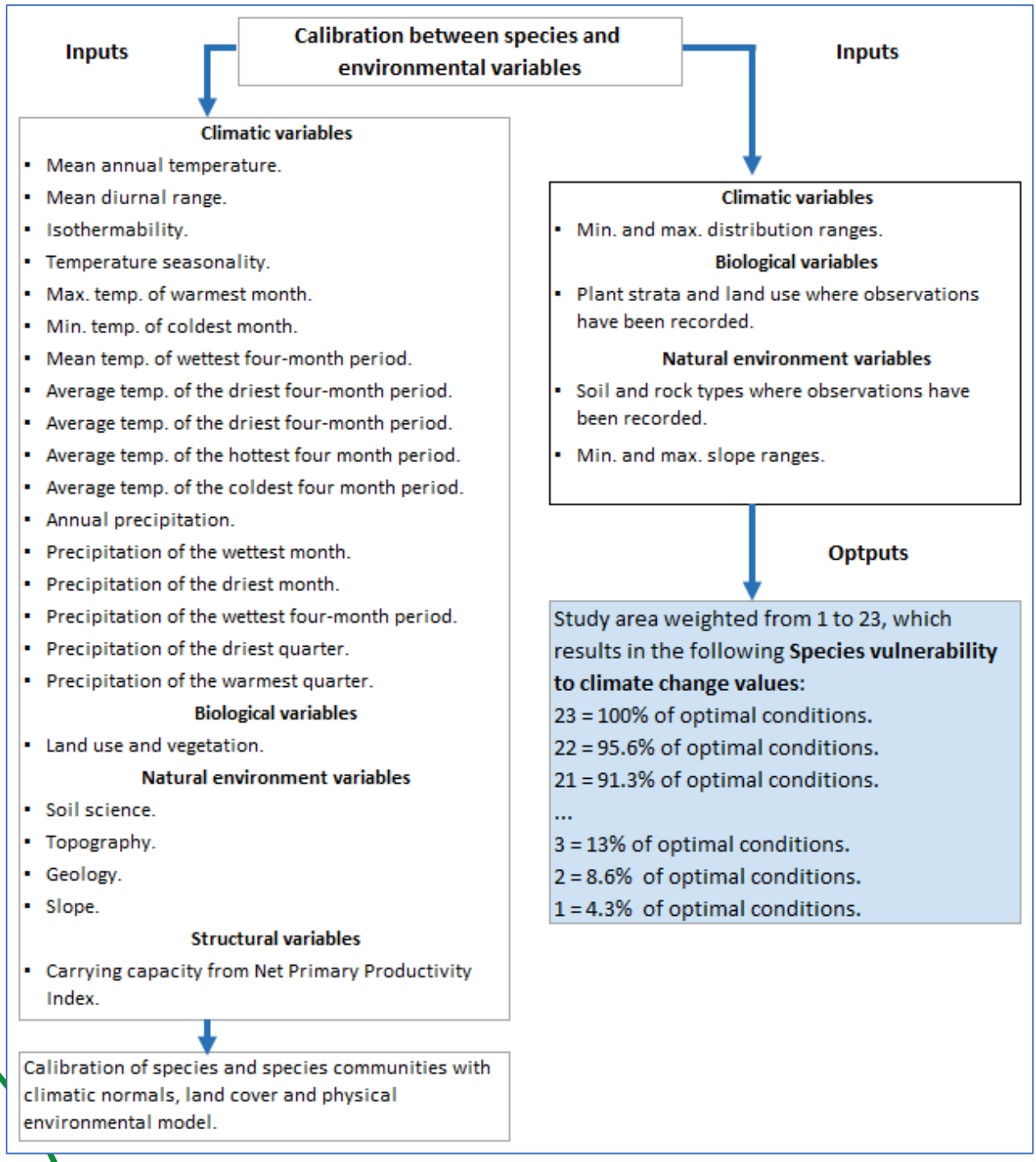
Inputs
Calibration between species and environmental variables
Inputs
Climatic variables
Mean annual temperature.
Mean diurnal range.
Isothermability.
Temperature seasonality.
Max. temp. of warmest month.
Min. temp. of coldest month.
Mean temp. of wettest four-month period.
Average temp. of the driest four-month period.
Average temp. of the driest four-month period.
Average temp. of the hottest four month period.
Average temp. of the coldest four month period.
Annual precipitation.
Precipitation of the wettest month.
Precipitation of the driest month.
Precipitation of the wettest four-month period.
Precipitation of the driest quarter.
Precipitation of the warmest quarter.
Biological variables
Land use and vegetation.
Natural environment variables
Soil science.
Topography.
Geology.
Slope.
Structural variables
Carrying capacity from Net Primary Productivity Index.
Calibration of species and species communities with climatic normals, land cover and physical environmental model.
Climatic variables
Min. and max. distribution ranges.
Biological variables
Plant strata and land use where observations have been recorded.
Natural environment variables
Soil and rock types where observations have been recorded.
Min. and max. slope ranges.
Optputs
Study area weighted from 1 to 23, which results in the following Species vulnerability to climate change values:
23 = 100% of optimal conditions.
22 = 95.6% of optimal conditions.
21 = 91.3% of optimal conditions.
...
3 = 13% of optimal conditions.
2 = 8.6% of optimal conditions.
1 = 4.3% of optimal conditions.

The Climpact approach uses the two-time horizons (current and future) to compare the results and identify possible trends (increase, decrease, or stability) in the spatial distribution of the optimal zones for the species. In this way, the percentages of each species will be evaluated in the current and future scenarios, assessing their behavior:

- If the project zone increases the percentage of conditions necessary for the adaptation of the species.
- If the project zone decreased the percentage of conditions necessary for the adaptation of the species.

The result of the application of the Climpact model to the project area is the value of the Species vulnerability to climate change index, which is then interpreted and relativized according to Table 7.

TABLE 7. RELATIVIZATION OF THE SPECIES VULNERABILITY TO CLIMATE CHANGE INDEX

Classification	SVCCI value	Relativized SVCII
Very high resilience	<10	1.00
High resilience	11 - 20	0.72
Medium resilience	21 - 40	0.44
Low resilience	41 - 60	0.15
Very low resilience	61 - 80	0.07
Non-resilient species	80 - 100	0.01

V.2.1.7 Biodiversity Index of Restored Area (BIRA)

The biodiversity index of the restored area is calculated using the Shannon–Wiener diversity index presented in Eq. 3 or Eq. 4, as appropriate, and then relativized according to Table 8.

TABLE 8. RELATIVIZATION OF THE BIODIVERSITY INDEX OF RESTORED AREAS.

Classification	BIRA value	Relativized BIRA
Very low	< 1.02	0.01
Low	1.03 - 1.53	0.14
Medium	1.54 - 2.11	0.32

Classification	BIRA value	Relativized BIRA
High	2.12 - 2.65	0.67
Very high	> 2.65	1.00

V.2.1.8 Biodiversity Index of the Preserved Area (BIPA)

The biodiversity index of the preserved area is calculated using the Shannon–Wiener diversity index presented in Eq. 3 or Eq. 4, as appropriate, and then relativized according to Table 9.

TABLE 9. RELATIVIZATION OF THE BIODIVERSITY INDEX OF PRESERVED AREAS.

Classification	BIPA value	Relativized BIPA
Very low	< 1.02	0.01
Low	1.03 - 1.53	0.14
Medium	1.54 - 2.11	0.32
High	2.12 - 2.65	0.67
Very high	> 2.65	1.00

V.3 MONITORING

Biodiversity monitoring for each project will be carried out during the 10 years in which the total credits will be issued; the periods of each monitoring will be determined in the specific Monitoring Plan for each project. Considering the results of the baseline as the reference parameter, which should not show a decrease throughout the project. Therefore, the verifications should evaluate each parameter analyzed in the baseline to monitor whether the project is effectively complying.

Project participants must monitor the variables presented in Table 10 on an annual basis.

TABLE 10. VARIABLES FOR ANNUAL MONITORING.

Variable	
BIKPS	Biodiversity Index of Key Protected Species.
BIPA	Biodiversity Index of the Preserved Area.
BIRA	Biodiversity Index of Restored Area.
EVCCI	Ecosystem Vulnerability to Climate Change Index.

FDI	Fractal Dimension Index.
FI	Fragmentation Index.
PA	Preserved area (m2).
RA	Restored area (m2).
SCI	Spatial Continuity Index.
SVCCI	Species Vulnerability to climate change.
TA	Total area (m2).

To feed the indices above, the following data streams are implicitly required on an ongoing basis:

Species-level data

Full flora and fauna inventories (direct counts and bioacoustic records) for all species, with explicit identification of IUCN- and nationally listed species for BIKPS.

Abundances of planted and naturally established individuals in restored areas (for Shannon index in BIRA).

Land cover and landscape configuration

Forest area (FA) and total area (TA) in the micro-basin or 1 km buffer, digitized from supervised/unsupervised satellite classifications (for FI and FDI).

Patch geometry of forest/vegetation (area and perimeter of each patch) to compute FDI and SCI.

Spatial stratifications: baseline preservation area strata, baseline restoration area strata, and other spatial environmental layers (hydrology, soils, etc.).

Climate and productivity variables

Current mean annual temperature and precipitation (to compute NPP via Eq. 8 and 9).

Projected 2050 temperature and precipitation under IPCC RCP 4.5, for NPP_2050 and EVCCI.

Species distribution and niche variables (for SVCCI)

Current and 2050 potential distribution of reforested species from Climpact: climatic, physical and biological conditions (temperature, precipitation, altitude, land use/vegetation, soils, slope, etc.) across the project zone.

Percentage of “optimal conditions” for each species in current vs. future scenarios, to place each species into SVCCI classes (very high resilience to non-resilient).

Project-level monitoring requirements

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Beyond the strictly quantitative indices, the methodology also implies monitoring of implementation and context variables that affect those indices:

Occurrence of degradation, deforestation, fire and other disturbances within project area and landscape, to verify that baseline conditions are not degraded and to update FI/SCI/FDI and EVCCI.

Management interventions and restoration actions (species used, planting designs, thinning, nurse species management), because they affect BIRA, BIPA, BIKPS and the landscape indices.

Compliance-related records: forest inventories, initial establishment data, and records of management interventions that underpin the monitored biodiversity outcomes.

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DOCUMENT HISTORY

Version	Date	Comments
1.0	19/01/2023.	First version of the methodology. Published as ASES ON-CHAIN-PROTOCOL Methodology for the Issuance of Verified Biodiversity Credits.
2.0	25/06/2023.	Version approved and released by the aOCP Steering Committee under the aOCP V.2.0 Framework.
3.0	16/01/2026.	The methodology was renamed to “aOCP Methodology for Biodiversity Restoration and Conservation” and restructured, while respecting its methodological essence.

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