Food and Agriculture Organization of the United Nations

Biodiversity Integrated Assessment and Computation Tool | B-INTACT

GUIDELINES

Second edition

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Food and Agriculture Organization of the United Nations
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Contents

Figures

Tables

Acknowledgements

Acronyms and abbreviations

AFD	*Agence Française de Développement*
AFOLU	Agriculture, Forestry and Other Land Use
B-INTACT	Biodiversity Integrated Assessment and Computation Tool
CA	Conservation Agriculture
CISL	Cambridge Institute for Sustainable Leadership
ESVD	Ecosystem Service Valuation Database
EX-ACT	Ex-Ante Carbon-balance Tool
FAO	Food and Agriculture Organization of the United Nations
GBS	Global Biodiversity Score
GHG	Greenhouse gas
GLOBIO	Global Biodiversity model
GMTI	Global mean temperature increase
IPM	Integrated pest management
ISSG	Invasive Species Specialist Group
IUCN	International Union for Conservation of Nature
MSA	Mean species abundance
PBF	Product Biodiversity Footprint
PBL	Netherlands Environmental Assessment Agency
PDF	Potentially disappeared fraction of species
STAR	Species Threat Abatement and Recovery metric
UNDP	United Nations Development Programme
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
WWF	World Wide Fund for Nature
ZSL	Zoological School of London

Executive summary

Biodiversity loss is accelerating at an unprecedented rate across the planet putting a great number of species on the brink of extinction. A decline in the plants, animals and micro-organisms threatens food security, sustainable development and the supply of vital ecosystem services. In order to meet the Sustainable Development Goals (SDGs) of the 2030 Agenda, there is an urgent need to take action to halt biodiversity loss and consequently ecosystem degradation. Since the introduction of the Aichi targets, released by the Convention on Biological Diversity (CBD) in 2010, the United Nations have been empowered with greater influence on decision-making impacting biodiversity. However, there was an urgent need for an easy-to-use tool to rapidly, yet effectively assess the impact on biodiversity posed by projects, programmes and policies.

As a timely response, the EX-ACT team from the Food and Agriculture Organization (FAO) of the United Nations has developed the Biodiversity Integrated Assessment and Computation Tool (B-INTACT). B-INTACT uniquely seeks to extend the scope of environmental assessments to capture biodiversity concerns, which are not accounted for in conventional carbon pricing. The tool is designed for users ranging from national investment banks, international financial institutions and policy decision-makers, and allows for a thorough biodiversity assessment of project-level activities in the Agriculture, Forestry and Land Use (AFOLU) sector.

The biodiversity assessment in the tool takes on a quantitative and qualitative approach. The quantitative approach considers a set of relationships for anthropogenic impacts on biodiversity from land use changes, habitat fragmentation, infrastructure and human encroachment. Biodiversity responses are quantified in the mean species abundance (MSA) metric, which expresses the mean abundance of original species in disturbed conditions relative to their abundance in an undisturbed habitat (where MSA = 1 highlights an entirely intact ecosystem and MSA = 0 highlights a fully destroyed ecosystem). Non-quantifiable impacts to biodiversity from project activities are assessed with a qualitative appraisal of the biodiversity sensitivity, management activities and agrobiodiversity practices, to complement the quantitative assessment.

Through its integrated environmental assessment, B-INTACT supports countries in accessing additional funds from international financial institutions and mechanisms to finance projects, programmes and policies. Its considerations can furthermore be included into Economic and Financial Analyses (EFA) and help project designers to evaluate and prioritize project activities with the greatest economic benefit and potential for biodiversity conservation and climate change mitigation.

Introduction

Biological diversity (herein referred to as biodiversity) is defined in Article 2 of the Convention on Biological Diversity (CBD) as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (CBD, 1992).

The synergetic achievement of food security, economic development and the preservation of the planet's natural resources through biodiversity conservation and climate change mitigation targets a high-level policy goal within the UN Sustainable Development Goals and the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC). Avoiding biodiversity-harming and greenhouse gases emission-intensive investments through economically viable, sustainable, low-emission development options is an essential requirement in achieving these policy goals.

Biodiversity provides a number of ecosystem services, which are directly or indirectly linked to our food security: biodiversity plays a role in maintaining healthy soils, controlling pests and providing habitat for wildlife that are vital to food production and agricultural livelihoods. In its State of the World's Biodiversity for Food and Agriculture publication of 2019, FAO emphasizes that "biodiversity underpins the capacity of farmers […] to produce food and a range of other goods and services in a vast variety of different biophysical and socio-economic environments. It increases resilience to shocks and stresses, provides opportunities to adapt production systems to emerging challenges and is a key resource in efforts to increase output in a sustainable way." And yet, in recent decades, concerns have grown around the environmental impact of the AFOLU sector, more specifically on the impact of agricultural activities on biodiversity. As a timely response, the EX-ACT team from FAO has developed the Biodiversity Integrated Assessment and Computation Tool (B-INTACT).

With its new Biodiversity Integrated Assessment and Computation Tool, the EX-ACT team of FAO offers a more holistic environmental assessment of projects, policies and investments in the AFOLU sector, adding a new biodiversity assessment to the widely recognized carbon accounting tool.

The present document provides guidance on how to use B-INTACT and covers the methodology of the Biodiversity Impact assessment. For the carbon-balance appraisal methodology, please refer to the methodology of the EX-ACT tool: www.fao.org/tc/exact/user-guidelines

The present guidelines are divided into five parts. **PART 2** provides an overview of B-INTACT, explaining how the tool is organized and what basic project information is required to initiate an assessment using the tool. **Part 2** covers the methodology and guidelines for the quantitative impact assessment of activities from projects, programmes, and investments on biodiversity. **Part 3** discusses the qualitative appraisal of non-quantifiable impacts to biodiversity. **Part 4** is dedicated to demonstrating the application of features from the EarthMap platform in computing baseline assessments with B-INTACT. And lastly, **Part 5** presents the various results that B-INTACT provides, along with how users can interpret them.

PART 1. Overview of B-INTACT

1.1 Organization of B-INTACT

B-INTACT is structured along six different tabs, which are listed hereafter:

1. Start
2. Biodiversity assessment
3. Qualitative assessment
4. Biodiversity results
5. Help
6. Definitions

1.2 Basic project information

The first tab of the Biodiversity Integrated Assessment and Computation Tool asks the user to provide basic project information on the country, climate and moisture regime, elevation and number of patches within the project site (see **Figure 1**). A drop-down menu will list all possible countries, climates and moisture regimes. The elevation should be specified in metres above sea-level (masl). The number of patches within the project site should be specified for both the "without-project" scenario (or baseline) and the "with-project scenario". In the current version of B-INTACT, the patch numbers are limited to 2 000 for both scenarios. For more information on the definition of a patch, please refer to 2.1.1. In case the climate and moisture regimes are unknown, the user can click on the Help button and will be redirected towards a help section to identify the basic ecological categories.

Figure 1. Start section of B-INTACT

Source: B-INTACT screenshot.

The user can provide more specific information on the mean annual temperature in °C, mean annual precipitation in mm, potential evapotranspiration in mm and elevation in metres above sea level. Based on the information provided for these four ecological variables, B-INTACT will identify the appropriate climate and moisture regime (see the example of Mali in **Figure 2**). Values for the mean annual temperature in °C, mean annual precipitation in mm, potential evapotranspiration in mm and elevation in metres above sea level can all be accessed on FAO's EarthMap platform (EarthMap.org). For more details on the classification of climate and moisture regimes, refer to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.

Figure 2.   Example of Mali in the B-INTACT help section
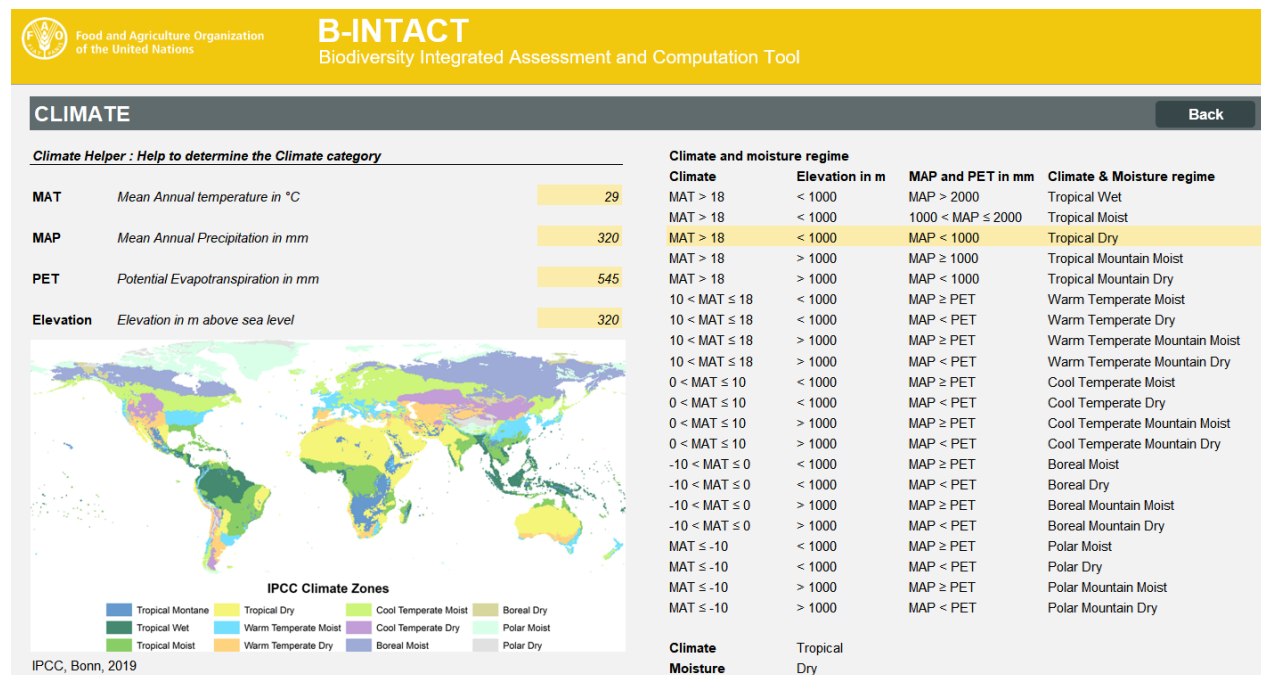
Source: B-INTACT screenshot.

PART 2. Quantitative approach

2.1 Methodology

2.1.1 Mean species abundance

The quantitative assessment of the Biodiversity Integrated Assessment and Computation Tool relies on the mean species abundance (MSA) metric, which expresses the mean abundance of original species in disturbed conditions relative to their abundance in an undisturbed habitat. MSA acts as an indicator of the degree to which an ecosystem is intact, and varies between 0 percent and 100 percent (or 0 and 1), where:

- MSA = 100 percent highlights an undisturbed ecosystem where all original species remain.
- MSA = 0 percent highlights a destroyed ecosystem with no original species left.

The MSA metric was chosen as the unit of measurement for B-INTACT mainly due to the fact that a relatively vast number of pressure-impact relationships that are relevant to AFOLU activities have been readily defined by credible sources. Moreover, with the use of the MSA metric, different weights could be given to different ecosystems, depending on priorities emanating from a specific context, a useful potential for a globally developed tool applied at local levels.

The methodology of the quantitative biodiversity assessment in B-INTACT is based on the Global Biodiversity (GLOBIO) model Version 3.6 developed by the Netherlands Environmental Assessment Agency (PBL), which was built on a set of quantitative relationships that describe six anthropogenic impacts on biodiversity: impacts of land use, climate change, atmospheric nitrogen deposition, disturbance by infrastructure, habitat fragmentation due to land use and infrastructure, and human encroachment. Biodiversity responses are quantified as the level of mean species abundance. A total of six major taxonomic groups are covered by GLOBIO: mammals, birds, reptiles, amphibians, terrestrial invertebrates and vascular plants.

Although B-INTACT applies the methodology of the GLOBIO model, major adaptations were made to fit the scope and purpose of the tool (see **Table 1**). Unlike the GLOBIO model, which focuses on global-level assessments, the Biodiversity Integrated Assessment and Computation Tool assesses impacts from project-level activities. Furthermore, while the GLOBIO model is used mainly for future impact estimates based on geo-spatialized trends data aggregated from a grid-cell level, B-INTACT is a land-based accounting system that aims to provide impact appraisals of expected project activities.

Table 1.   Differences in scope and purpose between GLOBIO and B-INTACT

	Scope	Purpose
GLOBIO	Global-level assessments	Future impact estimates based on geo-spatialized trends data
B-INTACT	Project-level assessments	Impact appraisals of expected project activities

Source: Alkemade *et al.,* 2009; Alkemade *et al.,* 2013; adapted from authors.

With this difference of scope and intended use in mind, B-INTACT adapts the GLOBIO model accordingly. B-INTACT is a land-based accounting system, which requires users to divide the project area into both baseline and project activity patches. Baseline or project activity patches are defined as a connected plot of land characterized by a single type of land use. Biodiversity impacts that can be identified on a patch-level such as the impacts of land use, disturbance by infrastructure, and habitat fragmentation are calculated per patch and expressed in MSA values. The aggregate MSA value of the patches is then derived from the area-weighted mean of the patch-level MSA values. This value is then multiplied by the project area-level MSA values from human encroachment impacts to obtain the final MSA. Both a without project (or baseline) and a with project MSA are derived for users to compare the difference in potential

biodiversity impact with and without the project. In other words, the MSA value of each baseline and project activity patch is calculated as follows:

$$MSA_i = (MSA_{LU,i} \times MSA_{I,i} \times MSA_{F,i})$$

(Eq. 1)

where MSA$_i$ is the overall MSA for project activity patch unit i and MSA$_{X,i}$ is the MSA corresponding with the impacts of land use (LU), infrastructure (I), and habitat fragmentation (F).

In the GLOBIO model, it is assumed that the direct land-use impacts of agriculture (cropland) and urban areas take precedence over all other impacts. In other words, the loss in MSA due to direct land-use impacts is so severe in croplands and urban areas that there are no further losses of MSA due to other pressures. For this reason, the equation for the MSA value of each baseline and project activity patch is adjusted as follows:

if $\qquad\qquad LU = cropland\ OR\ LU = urban, MSA_i = MSA_{LU,i}$

else $\qquad\qquad MSA_i = (MSA_{LU,i} \times MSA_{I,i} \times MSA_{F,i})$

(Eq. 2)

The overall baseline and project MSA of the project area is derived as follows:

$$MSA_p = \sum_{i=1}^{i=n}(MSA_i * S_i / \sum_{i=1}^{i=n} S_i) \times MSA_{HE,p}$$

(Eq. 3)

where MSA$_p$ is the overall baseline or project MSA of the total project area, MSA$_i$ is the MSA of baseline or project activity patch i, and S$_i$ is the surface area of baseline or project activity patch i. MSA$_{HE,p}$ is the baseline or project MSA corresponding with the impacts of human encroachment (HE).

2.2 Policy indicators

2.2.1 Area of biodiversity loss

One of the key objectives of the policy indicators is to tranform the abstract concept of mean species abundance into more accessible and comprehensible units for decision makers. The first step towards a practical policy indicator is to create a surface area equivalent of the MSA scores, namely the MSA.ha, which represents the area of biodiversity loss. MSA.ha is the product of the inverted overall MSA score multiplied by the total project area.

$$MSA.ha_p = (1 - MSA_p) * S_p$$

(Eq. 4)

where MSA.ha$_p$ is the total area of biodiversity loss, MSA$_p$ is the overall MSA of the total project area and S$_p$ is the total project area in hectares.

In practice, this translates into the following:

- For a surface area of 100 ha of irrigated annual cropland (MSA = 0.05), the surface area equivalent of a fully intact ecosystem is 5 ha.

- Similarly, the conversion of 100 ha of natural forest (MSA = 1) to moderately degraded grasslands (MSA = 0.6) would correspond to a biodiversity loss of (100−60 percent) x 100 ha = 40 ha. Essentially, this is equivalent to the biodiversity loss one would expect from a conversion of 40 ha of natural forest into a completely unnatural surface (e.g. concrete parking lot).

For decision-makers, the MSA.ha score can be interpreted as the area of biodiversity loss. For ease of communication, the loss of x MSA.ha corresponds to the biodiversity loss from the conversion of x ha of a completely intact ecosystem into a completely destroyed one. As stated above, one can imagine this as the equivalent biodiversity loss one would expect from x ha of natural forest being converted into a concrete parking lot.

2.2.2 Added or lost social value of biodiversity

Assuming that MSA is an indicator reflecting the level of damage to an ecosystem, it is possible to assign a monetary value per hectare to the MSA indicator. It is safe to presume that a complete loss of biodiversity corresponds to an equivalent complete loss of the supply of ecosystem services from a given area of intervention. The tool developers therefore decided to link the social value of biodiversity to the ecosystem service values estimated in the Ecosystem Services Valuation Database (ESVD).

ESVD is a follow-up to the "The Economics of Ecosystems and Biodiversity" (TEEB) database, which contained over 1 300 data points from 267 case studies on monetary values of ecosystem services across all biomes and is described in De Groot *et al.* (2012). The Ecosystem Services Valuation Database (ESVD) is a global database containing value observations for all biomes and all ecosystem services. De Groot *et al.* (2020) specify, however, that "the data is not globally representative and the current sample of values reflects the availability of valuation studies, the interests of the funding organisation, and the thematic expertise of the researchers involved. The data is therefore currently skewed towards values for the UK (1 360 value records or 36 percent of the total) with focus on inland wetlands and coastal systems." The data contained in the ESVD is subject to an on-going review process by invited expert reviewers. At the time of release (June 2020), 21 reviewers submitted reviewed data, and with their help approximately 800 value records have been reviewed (about 20% of the total). The review status of each value record is indicated in the database and is updated periodically as the review process continues. The Ecosystem Service Valuation Database and relevant documentation can be accessed on www.es-partnership.org/esvd

The added or lost social value of biodiversity from the project can be calculated as follows:

$$SV_p = \left(\sum_{i=1}^{i=n} (MSA_{i,p} * S_{i,p} * ESV_{i,p}) \times MSA_{HE,p} \right) - \left(\sum_{i=1}^{i=n} (MSA_{i,b} * S_{i,b} * ESV_{i,b}) \times MSA_{HE,b} \right)$$

(Eq. 5)

Where SV_p is the added or lost social value of biodiversity due to project implementation, $MSA_{i,p}$ is the MSA of project activity patch i, $S_{i,p}$ is the surface area of project activity patch i, $ESV_{i,p}$ is the ecosystem service value of project activity patch i, $MSA_{HE,p}$ is the project MSA corresponding to the impacts of human encroachment (HE), $MSA_{i,b}$ is the MSA of baseline activity patch i, $S_{i,b}$ is the surface area of baseline activity patch i, $ESV_{i,b}$ is the ecosystem service value of baseline activity patch i, $MSA_{HE,b}$ is the baseline MSA corresponding to the impacts of human encroachment (HE).

As the MSA indicator already factors in biodiversity intactness differences for non-natural land uses, it is important to note that only ecosystem service values of intact ecosystems should be considered in order not to overestimate the project impacts. That is why the baseline and project ecosystem service values ($ESV_{i,b}$ and $ESV_{i,p}$) both refer to the ecosystem service values of an intact natural land use (refer to 2.3.3 and **Table 5** for a definition and overview of the natural land uses). In line with the methodology described above, **Table 2** represents the terrestrial biomes and ecosystems that are considered as natural ecosystems in B-INTACT among the biomes and ecosystems included in ESVD. For all other land uses, B-INTACT takes the ecosystem service value of grasslands as a default option.

Table 2.   Natural biomes and ecosystems in B-INTACT

ESVD biomes	ESVD ecosystems
Coastal systems	Mangroves
Tropical forests	Tropical rain forest, Tropical dry forest, Tropical cloud forests
Temperate forests	Temperate rain or evergreen forest, Temperate deciduous forest, Boreal/coniferous forest ('Taiga')
Wood- and shrubland	Tropical wood- and shrubland, Mediterranean wood- and shrubland, Temperate wood- and shrubland, Heathland
Grass- and rangeland	Savanna, Tropical grasslands, Temperate grasslands, Steppe (dry, cold grassland)
Desert	True desert (sand/rock/salt), Semi-desert
Tundra	Alpine Tundra, Arctic tundra
High mountain and polar systems	High mountain forest, High mountain Grassland, High mountain snow and ice, Polar
Inland un- or sparsely vegetated	Underground systems, Inland rock formations, Other (inland un-or sparsely vegetated)

Source: Authors' elaboration based on de Groot *et al.,* 2020.

2.2.3   Mean species abundance plus

One problem commonly identified with intactness metrics like MSA is the lack of differentiation between the ecological value of sites with the same type of land use. To complement this, B-INTACT gives users the option to incorporate a coefficient for the ecological value of each project activity patch, which is determined based on spatialized data from earthmap. This would factor in the element of species vulnerability, extinction risk and/or species endemicity which can lead to better decision-making in project design.

The Mean Species Abundance Plus (MSA+) indicator with the coefficient to factor in the ecological value of patches included is calculated as follows:

$$MSA_p + = \sum_{i=1}^{i=n}(A_i * MSA_i * S_i / \sum_{i=1}^{i=n} S_i) \times MSA_{E,p}$$

(Eq. 6)

where MSA_p+ is an adjusted MSA indicator for the ecological value of the total project area, A_i is the coefficient for the ecological value of project activity patch i. A_i is a normalized value that ranges from 0 to 1.

2.3 Biodiversity pressures

B-INTACT considers four anthropogenic impacts on biodiversity, being 1) the impacts of land use, 2) disturbance by infrastructure, 3) habitat fragmentation due to land use and infrastructure, and 4) human encroachment. In the following section, the different pressures are explained in detail.

2.3.1 Impact of land use

Cause-effect relationships between land use and MSA were identified under the GLOBIO model, based on findings from studies reporting species composition in given types and intensities of land use, as well as in undisturbed reference situations. The MSA$_{LU}$ values assigned to each land use are shown in **Table 3**, along with descriptions of the different land use classes. The GLOBIO land use classes and the refined IPCC land use classes have been aligned as shown in **Table 3** based on the opinions of FAO experts.

Table 3.   MSA$_{LU}$ values by land use type

Refined IPCC land use	Description of refined IPPC land use class		GLOBIO land use class	Description of GLOBIO land use class	MSA$_{LU}$
Forest zone (default)	Forest zone: All land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory (IPCC, 2006)	Natural forest: A forest composed of indigenous trees and not classified as a forest plantation (IPCC, 2006)	Forest – natural	Minimal disturbance, where flora and fauna species abundance are near pristine	1.00
Forest zone (selective logging)		See GLOBIO description	Forest – selective logging (lightly used natural forest)	Forests with extractive use and associated disturbance like hunting and selective logging, where timber extraction is followed by a long period of re-growth with naturally occurring tree species	0.70
Forest zone (reduced impact logging)		See GLOBIO description	Forest – reduced impact logging	Limited selective logging of semi-natural forest with reduced impact logging management	0.85
Forest zone (clear-cut harvesting)		See GLOBIO description	Forest – clear-cut harvesting	Areas originally covered with forest or woodlands, where vegetation has been removed, forest is re-growing or has a different cover and is no longer in use	0.50
Forest plantation (default)	Forest plantation: Forest stands established by planting or/and seeding in the process of afforestation or reforestation and meeting all the following criteria: one or two species at planting, even age class, and regular spacing (IPCC, 2006)		Forest – plantation	Planted forests often with exotic species Converted forests with a high degree of human management	0.30
Grassland (non-degraded)	Non-degraded and sustainably managed grassland (IPCC, 2006)		Natural grassland	Grassland or shrubland-dominated vegetation (for example, steppe, tundra, or savannah)	1.00

| Refined IPCC land use	Description of refined IPPC land use class		GLOBIO land use class	Description of GLOBIO land use class	MSA_{LU}
Grassland (moderately degraded)	Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) (IPCC, 2006)		Pasture – moderately to intensively used	Grasslands where wildlife is replaced by grazing livestock	0.60
Grassland (severely degraded)	[Grassland with] major long-term loss of productivity and vegetation cover, due to severe mechanical damage to the vegetation and/or severe soil erosion (IPCC, 2006)		Pasture – man-made	Forests and woodlands that have been converted to grasslands for livestock grazing	0.30
Annual cropland (with any type of improvement)	Annual Cropland: Arable and tillable land where annual crops (including cereals, oils seeds, vegetables, root crops and forages) are cultivated (IPCC, 2006)	Improvements include Improved agronomic practices, nutrient management, no tillage & residue retention, water management, manure application	Extensive cropland (Low-input agriculture)	Subsistence and traditional farming, extensive farming, and low external input agriculture	0.30
Annual cropland (without any type of improvement)		None of the improvements above	Intensive cropland	High external input agriculture, conventional agriculture, mostly with a degree of regional specialization	0.10
Irrigated annual cropland		See GLOBIO description	Irrigated cropland	Irrigation-based agriculture, drainage-based agriculture	0.05
Flooded rice	Rice fields flooded permanently or for part of the year (IPCC definition)		–	–	0.30
Extensive agroforestry	Perennial systems: gathered trees and shrubs, in combination with herbaceous crops (e.g. agroforestry) or orchards,	Extensive agroforestry systems include: Multistrata system, Parklands, Shaded perennial-crop systems, Silvopastures	Agroforestry	Agricultural production intercropped with (native) trees. Trees are kept for shade or as wind shelter	0.50

Refined IPCC land use	Description of refined IPPC land use class		GLOBIO land use class	Description of GLOBIO land use class	MSA_LU
Intensive agroforestry	vineyards and plantations such as cocoa, coffee, tea, oil palm, coconut, rubber trees, and bananas (IPCC, 2006)	Intensive agroforestry systems include: Hedgerows, Alley cropping, Fallows, Silvoarable systems	Woody biofuels and perennial crops	Cultivated perennial crops, including biofuel crops	0.30
Set-aside land	Land with intact vegetation that is not in use, but with some soil disturbance (refined IPCC definition)		Secondary vegetation	Land that was formally in use, but has been converted into natural land	0.90
Degraded land	Native vegetation that has been heavily disturbed. Land with low levels of biomass and soil carbon (refined IPCC definition)		–	–	0.30
Other (nominal)	Land with undisturbed soils, but no vegetation (IPCC definition). See GLOBIO definitions for bare area and snow and ice.		Bare area	Areas permanently without vegetation (for example, deserts, high alpine areas)	1.00
			Snow and ice	Areas permanently covered with snow or ice considered as undisturbed areas	1.00
Other (degraded)	Settlements: All developed land (i.e., residential, transportation, commercial and production infrastructure of any size, unless it is already included under other land-use categories) (IPCC, 2006)		Urban area	Areas with more than 80 percent of built up, representing densely populated cities	0.05

Source: IPCC, 2006; Alkemade *et al.,* 2009; Alkemade *et al.,* 2013; Schipper *et al.,* 2016; GLOBIO reference database (www.globio.info).

Users are required to first specify the number of patches (maximum 1 000) both without and with the project (see **Figure 3**). Note that the number of patches may change without and with the project, as the nature of the land use may be altered due to the project, or its absence. Then, users can specify the land use type and land area (ha) of each patch (see **Figure 3**). The land use types can be selected from a drop-down list, and are named based on the refined IPCC land use classes described in **Table 3**. Users are directed to the definitions and specific MSA_LU values of each land use class when clicking on the question mark in the module (see **Figure 3**). A "Check areas!" warning will appear in red if the sum of the land areas of both the without and with project scenarios do not equal each other.

Figure 3.   Pressure 1: land use
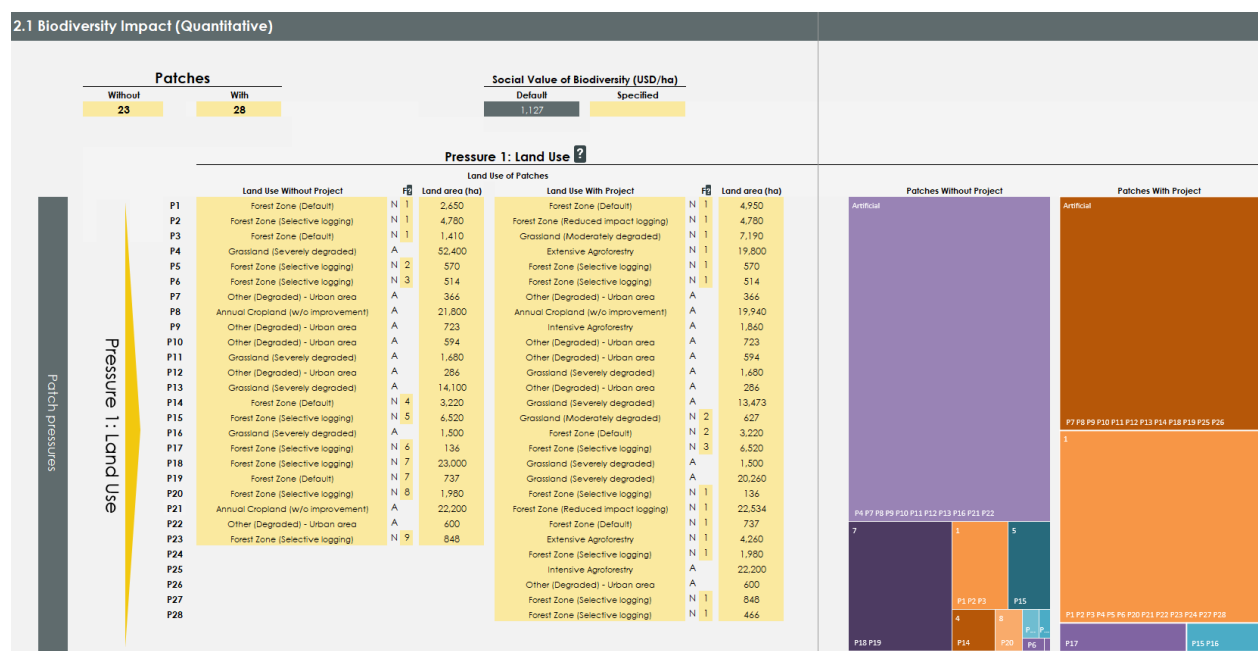
Source: B-INTACT screenshot.

2.3.2   Impact of infrastructure

Biodiversity disturbance from infrastructure is assumed to be confined to an impact zone of 1 km^2 around infrastructural elements under the GLOBIO model. Both roads and railways are considered as biodiversity disturbing infrastructure. The cause-effect relationship between infrastructure and MSA are quantified based on a meta-analysis from Benítez-López *et al.* (2010), assigning the overall MSA$_I$ for the 1 km impact zone as 0.78. As the GLOBIO model assumes that infrastructure does not cause additional MSA loss in urban areas and cropland apart from the direct effect of land use, the MSA$_I$ for urban areas and cropland is 1.

Users can scroll the sheet to the right to fill out the required information for the impacts of infrastructure per patch. The tool asks users to specify the total km of newly built roads and railways in each patch for both without and with project scenarios, as shown in **Figure 4**. With this, a 1 km^2 impact zone to both sides of the built infrastructure is delineated based on the extent of roads specified by the users.

As an example, if users specify 2.5 km of roads and railways being newly built with the project on a patch of grassland of 1 000 hectares, the MSA$_I$ would be calculated as the following:

$$1 - ((250 \times 2) / (100 / 100) \times (1 - 0.78)) = 0.89.$$

Figure 4.   Pressure 2: infrastructure

2.1 Biodiversity Impact (Quantitative)

Patches — Without: 23 — With: 28

Social Value of Biodiversity (USD/ha) — Default: 1,127 — Specified:

Pressure 1: Land Use — Land Use of Patches

Pressure 2: Infrastructure — Roads and Railways (in km)

	Land Use Without Project	F	Land area (ha)	Land Use With Project	F	Land area (ha)	Without project	With project
P1	Forest Zone (Default)	N 1	2,650	Forest Zone (Default)	N 1	4,950	0.0	0.0
P2	Forest Zone (Selective logging)	N 1	4,780	Forest Zone (Reduced impact logging)	N 1	4,780	0.0	0.0
P3	Forest Zone (Default)	N 1	1,410	Grassland (Moderately degraded)	N 1	7,190	0.0	1.3
P4	Grassland (Severely degraded)	A	52,400	Extensive Agroforestry	N 1	19,800	0.0	9.0
P5	Forest Zone (Selective logging)	N 2	570	Forest Zone (Selective logging)	N 1	570	0.0	0.0
P6	Forest Zone (Selective logging)	N 3	514	Forest Zone (Selective logging)	N 1	514	0.0	0.0
P7	Other (Degraded) - Urban area	A	366	Other (Degraded) - Urban area	A	366	0.0	0.0
P8	Annual Cropland (w/o improvement)	A	21,800	Annual Cropland (w/o improvement)	A	19,940	0.0	0.0
P9	Other (Degraded) - Urban area	A	723	Intensive Agroforestry	A	1,860	0.0	0.0
P10	Other (Degraded) - Urban area	A	594	Other (Degraded) - Urban area	A	723	0.0	0.0
P11	Grassland (Severely degraded)	A	1,680	Other (Degraded) - Urban area	A	594	0.0	0.0
P12	Other (Degraded) - Urban area	A	286	Grassland (Severely degraded)	A	1,680	0.0	0.0
P13	Grassland (Severely degraded)	A	14,100	Other (Degraded) - Urban area	A	286	0.0	0.0
P14	Forest Zone (Default)	N 4	3,220	Grassland (Severely degraded)	A	13,473	0.0	0.0
P15	Forest Zone (Selective logging)	N 5	6,520	Grassland (Moderately degraded)	N 2	627	0.0	0.0
P16	Grassland (Severely degraded)	A	1,500	Forest Zone (Default)	N 2	3,220	0.0	0.0
P17	Forest Zone (Selective logging)	N 6	136	Forest Zone (Selective logging)	N 3	6,520	0.0	0.0
P18	Forest Zone (Selective logging)	N 7	23,000	Grassland (Severely degraded)	A	1,500	13.5	0.0
P19	Forest Zone (Default)	N 7	737	Grassland (Severely degraded)	A	20,260	0.0	0.0
P20	Forest Zone (Selective logging)	N 8	1,980	Forest Zone (Selective logging)	N 1	136	8.8	0.0
P21	Annual Cropland (w/o improvement)	A	22,200	Forest Zone (Reduced impact logging)	N 1	22,534	0.0	13.5
P22	Other (Degraded) - Urban area	A	600	Forest Zone (Default)	N 1	737	0.0	0.0
P23	Forest Zone (Selective logging)	N 9	848	Extensive Agroforestry	N 1	4,260	0.0	5.7
P24				Forest Zone (Selective logging)	N 1	1,980		0.0
P25				Intensive Agroforestry	A	22,200		0.0
P26				Other (Degraded) - Urban area	A	600		0.0
P27				Forest Zone (Selective logging)	N 1	848		0.0
P28				Forest Zone (Selective logging)	N 1	466		0.0

Source: B-INTACT screenshot.

2.3.3   Impact of habitat fragmentation

Habitat fragmentation is assumed to be induced by roads, cropland and urban areas. The MSA_F values by size range of non-fragmented area in the GLOBIO model are specified in **Table 3**.

Table 4.   GLOBIO MSA_F values by size range of non-fragmented natural area

Non-fragmented natural area (km^2)	MSA_F
0−1	0.35
1−10	0.45
10−100	0.65
100−1 000	0.90
1 000−10 000	0.98
> 10 000	1.00

Source: Schipper *et al.,* 2016.

To identify the impact of fragmentation, users of B-INTACT are asked to report the different non-fragmented natural areas without and with the project. To do this, users need to group the patches of natural areas that are geophysically connected to one another (see **Figure 4**). The tool indicates the selected land use for each patch as either natural (N) or non-natural/artificial (A). The categorization of the land use classes into natural and non-natural areas is as shown in **Table 5**.

Additionally, the tool will provide an automatically generated simplified box map of how fragmented the total project area is both without and with the project, using the land areas provided by the users (see **Figure 3**).

Table 5.   Categorization of natural and non-natural areas

Natural areas (N)	Non-natural areas (A)
Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), extensive agroforestry, set-aside land, degraded land, other (nominal)	Grassland (severely degraded), annual cropland (w/ any type of improvement), annual cropland (w/o any type of improvement), irrigated annual cropland, flooded rice, intensive agroforestry, other (degraded)

Source: Alkemade *et al.,* 2009; Alkemade *et al.,* 2013; adapted from authors.

Figure 5.   Pressure 3: fragmentation

2.1 Biodiversity Impact (Quantitative)

Patches — Without: 23, With: 28

Social Value of Biodiversity (USD/ha) — Default: 1,127, Specified: ___

Patch	Pressure 1: Land Use — Land Use Without Project	N/A	F	Land area (ha)	Land Use With Project	N/A	F	Land area (ha)	Pressure 3: Fragmentation — Non-fragmented natural area (ha) Without project	With project
P1	Forest Zone (Default)	N	1	2,650	Forest Zone (Default)	N	1	4,950	8,840	68,765
P2	Forest Zone (Selective logging)	N	1	4,780	Forest Zone (Reduced impact logging)	N	1	4,780	8,840	68,765
P3	Forest Zone (Default)	N	1	1,410	Grassland (Moderately degraded)	N	1	7,190	8,840	68,765
P4	Grassland (Severely degraded)	A		52,400	Extensive Agroforestry	N	1	19,800	Artificial	68,765
P5	Forest Zone (Selective logging)	N	2	570	Forest Zone (Selective logging)	N	1	570	570	68,765
P6	Forest Zone (Selective logging)	N	3	514	Forest Zone (Selective logging)	N	1	514	514	68,765
P7	Other (Degraded) - Urban area	A		366	Other (Degraded) - Urban area	A		366	Artificial	Artificial
P8	Annual Cropland (w/o improvement)	A		21,800	Annual Cropland (w/o improvement)	A		19,940	Artificial	Artificial
P9	Other (Degraded) - Urban area	A		723	Intensive Agroforestry	A		1,860	Artificial	Artificial
P10	Other (Degraded) - Urban area	A		594	Other (Degraded) - Urban area	A		723	Artificial	Artificial
P11	Grassland (Severely degraded)	A		1,680	Other (Degraded) - Urban area	A		594	Artificial	Artificial
P12	Other (Degraded) - Urban area	A		286	Grassland (Severely degraded)	A		1,680	Artificial	Artificial
P13	Grassland (Severely degraded)	A		14,100	Other (Degraded) - Urban area	A		286	Artificial	Artificial
P14	Forest Zone (Default)	N	4	3,220	Grassland (Severely degraded)	A		13,473	3,220	Artificial
P15	Forest Zone (Selective logging)	N	5	6,520	Grassland (Moderately degraded)	N	2	627	6,520	3,847
P16	Grassland (Severely degraded)	A		1,500	Forest Zone (Default)	N	2	3,220	Artificial	3,847
P17	Forest Zone (Selective logging)	N	6	136	Forest Zone (Selective logging)	N	3	6,520	136	6,520
P18	Forest Zone (Selective logging)	N	7	23,000	Grassland (Severely degraded)	A		1,500	23,737	Artificial
P19	Forest Zone (Default)	N	7	737	Grassland (Severely degraded)	A		20,260	23,737	Artificial
P20	Forest Zone (Selective logging)	N	8	1,980	Forest Zone (Selective logging)	N	1	136	1,980	68,765
P21	Annual Cropland (w/o improvement)	A		22,200	Forest Zone (Reduced impact logging)	N	1	22,534	Artificial	68,765
P22	Other (Degraded) - Urban area	A		600	Forest Zone (Default)	N	1	737	Artificial	68,765
P23	Forest Zone (Selective logging)	N	9	848	Extensive Agroforestry	N	1	4,260	848	68,765
P24					Forest Zone (Selective logging)	N	1	1,980		68,765
P25					Intensive Agroforestry	A		22,200		Artificial
P26					Other (Degraded) - Urban area	A		600		Artificial
P27					Forest Zone (Selective logging)	N	1	848		68,765
P28					Forest Zone (Selective logging)	N	1	466		68,765

Source: B-INTACT screenshot.

Once the users group the natural patches into connected stretches of non-fragmented natural area, the tool automatically calculates the corresponding patch-level MSA_F values (see **Figure 5**). Users can click on the question mark button next to the "F" to view the definition of non-fragmented natural area, which is specified as the following: An area of connected natural land undisturbed by cropland (including grasslands used for intensive grazing) nor urban areas. B-INTACT assigns MSA_F using the formulas specified in **Table 6** which are derived from the MSA_F values of the GLOBIO model shown in **Table 4**.

Figure 6. Patch-level MSA values by impact

| MSA for each patch and pressure | | | | | |
| MSA (LU) | | MSA (I) | | MSA (F) | |
W/o P	W/P	W/o P	W/P	W/o P	W/P
1.00	1.00	1.00	1.00	0.90	0.96
0.70	0.85	1.00	1.00	0.90	0.96
1.00	0.60	1.00	1.00	0.90	0.96
0.30	0.50	1.00	1.00	1.00	0.96
0.70	0.70	1.00	1.00	0.58	0.96
0.70	0.70	1.00	1.00	0.56	0.96
0.05	0.05	1.00	1.00	1.00	1.00
0.10	0.10	1.00	1.00	1.00	1.00
0.05	0.30	1.00	1.00	1.00	1.00
0.05	0.05	1.00	1.00	1.00	1.00
0.30	0.05	1.00	1.00	1.00	1.00
0.05	0.30	1.00	1.00	1.00	1.00
0.30	0.05	1.00	1.00	1.00	1.00
1.00	0.30	1.00	1.00	0.74	1.00
0.70	0.60	1.00	1.00	0.83	0.76
0.30	1.00	1.00	1.00	1.00	0.76
0.70	0.70	1.00	1.00	0.48	0.83
0.70	0.30	1.00	1.00	0.92	1.00
1.00	0.30	1.00	1.00	0.92	1.00
0.70	0.70	1.00	1.00	0.71	0.96
0.10	0.85	1.00	1.00	1.00	0.96
0.05	1.00	1.00	1.00	1.00	0.96
0.70	0.50	1.00	1.00	0.64	0.96
	0.70		1.00		0.96
	0.30		1.00		1.00
	0.05		1.00		1.00
	0.70		1.00		0.96
	0.70		1.00		0.96

MSA Patch Results

Source: B-INTACT screenshot.

Table 6. B-INTACT MSAF values by size range of non-fragmented natural area

Non-fragmented natural area (ha) = F	MSA$_F$
$0 \leq F < 100$	$0.0035 \times F$
$100 \leq F < 1\,000$	$0.0001 \times F + 0.3389$
$1\,000 \leq F < 10\,000$	$2E\text{-}05 \times F + 0.4278$
$10\,000 \leq F < 100\,000$	$3E\text{-}06 \times F + 0.6222$
$100\,000 \leq F < 1\,000\,000$	$9E\text{-}08 \times F + 0.8911$
$F \geq 1\,000\,000$	1.00

Source: Alkemade *et al.,* 2009; Alkemade *et al.,* 2013; adapted from authors.

Again, as the GLOBIO model assumes that the direct effect of land use takes precedence in croplands and urban areas, the MSA$_F$ incorporated in the final MSA calculation is as follows: $(MSA_F \times P_{natural}) + (1 \times P_{crop,urban})$ where $P_{natural}$ is the proportion of natural area and $P_{crop,urban}$ is the proportion of cropland and/or urban area.

2.3.4 Impact of human encroachment

Human encroachment can be defined as anthropogenic activities in otherwise natural areas, comprising of hunting, food and fuel gathering, recreation, and human settlements. The GLOBIO model assumes that a proportion of cropland and urban area of 1.5 percent is sufficient to have the entire (project) area influenced by human encroachment, based on estimates from model simulations. Based on a review of studies, the GLOBIO model estimates the MSA$_E$ from human encroachment to be 0.85 if the proportion of cropland and/or urban area is 1.5 percent or greater, and $1 - ((P_{crop,urban} / 0.015) \times (1-0.85))$ if the proportion of cropland and/or urban area is less than 1.5 percent, where $P_{crop,urban}$ is the proportion of cropland and/or urban area.

Based on the patch areas specified by the users, B-INTACT automatically calculates the proportion of cropland and/or urban area for both the without and with project scenarios (see **Figure 7**). With this, the MSA_E is derived using the equation above.

Figure 7.   Pressure 4: human encroachment

Source: B-INTACT screenshot.

2.3.5   Other biodiversity pressures not covered by B-INTACT

The GLOBIO model also takes into account the impact of nitrogen deposition and climate change on biodiversity. The FAO experts and a panel of biodiversity experts agreed to exclude both impacts from the B-INTACT assessment methodology. For a review of these additional pressures, refer to **Annex A.1.3.**

2.4 Social value of intact biodiversity

Based on the project information provided on the country, climate, moisture regime and altitude in the description section, B-INTACT proposes the default ecosystem service value for each of the patches (Tier 1). The default values are derived from large scale analyses of empirical evidence within ESVD and are subject to change with the addition and review of new data in the database. Therefore, the summary values do not aim to illustrate the absolute economic value of an intact patch of a natural ecosystem, but rather reflects the current state of knowledge that is included in the database. B-INTACT also provides the user with the option to factor in location-specific ecosystem service values through a Tier 2 and Tier 3 approach (see **Figure 8**). The Tier 2 approach allows users to further specify the ecosystem distribution as percentage of the total area, whereas the Tier 3 approach gives users the option to insert their own ecosystem service values at patch-level. The Ecosystem Service Valuation Database can be accessed via www.es-partnership.org/esvd.

**Figure 8.   Ecosystem service valuation – Tier 1, Tier 2 and Tier 3**

Source: B-INTACT screenshot.

2.5 Ecological value with World Bank's open-access terrestrial biodiversity database

To compensate for the ineptitude of the MSA metric in factoring in the ecological value of project sites, the biodiversity tool provides users with the option to weight the identified patches based on geo-spatialized values of total biome vulnerability, the extinction risk of species or the total endemicity, developed by World Bank's open-access Terrestrial Biodiversity database using data from the IUCN (Range maps of amphibians, mammals and reptiles from unpublished shapefiles), Birdlife International (Range maps of birds from unpublished shapefiles), the IUCN Red List and WWF. The Terrestrial Biodiversity database was constructed by integrating comprehensive information from overlapping habitat maps of 6 532 amphibians, 5 435 mammals, 4 291 reptiles and 11 126 birds. These authoritative habitat maps represent all known and catalogued species in each area from the IUCN and Birdlife International, as well as information on 827 distinctive ecoregions from WWF covering the entire terrestrial world. The database provides measures for each square kilometer of global territory. The total biome vulnerability score, index of the extinction risk of species and total endemicity score can all be accessed on FAO's EarthMap platform (EarthMap.org), as shown in **Figure 9**.

Figure 9.   Extinction risk score of Oaxaca from FAO's EarthMap platform
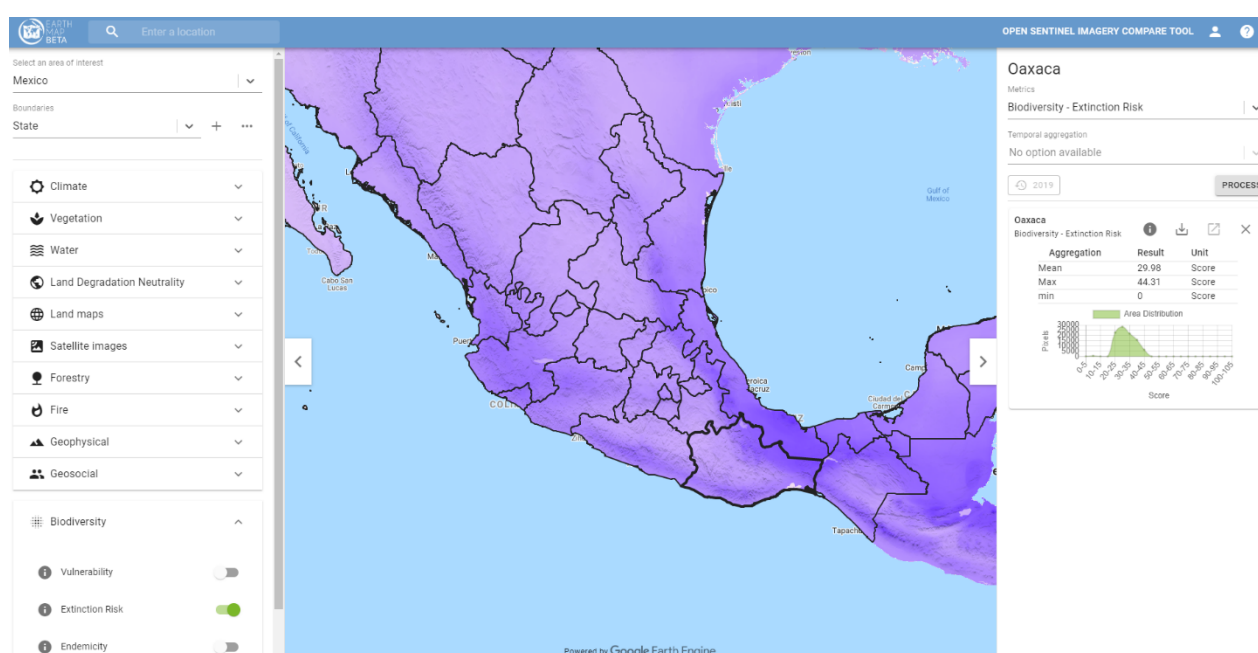
Note: Map boundaries comply with UN World map, February 2020.
Source: EarthMap screenshot.

For the ecological value to be included in the biodiversity assessment, the following action and steps are required by the user:

1. In the section "Include weights for ecological value", the user should select "Yes".

2. The user should then decide on the type of ecological value to be included in the ecological value-adjusted biodiversity assessment. The user can choose between "Vulnerability", "Extinction risk" and "Endemicity".

3. The user should identify the ecological value for each patch using EarthMap, as shown in **Figure 9** (EarthMap offers the user the option to upload KML files or to draw the proper patches on the map). EarthMap is a free online tool. However, in order to access EarthMap, the user must use or create a Google account and give consent to the terms and conditions of EarthMap.

4. The user should enter the ecological value for each patch into B-INTACT.

The tool automatically normalizes the values to range from 0 to 1, with higher values signifying higher levels of either vulnerability, extinction risk or endemicity. This score is incorporated as a coefficient to calculate the MSA plus.

2.5.1   Total biome vulnerability score

The total biome vulnerability score is identified from the within-cell shares of the WWF ecoregions. It is one of the indicators in the World Bank's open-access Terrestrial Biodiversity database described above. The total biome vulnerability score is measured on a scale from 0 to 100. An example of the inclusion of the total biome vulnerability score as ecological value weight into the B-INTACT assessment is shown in Figure 10.

Figure 10.   Ecological value with total biome vulnerability score

Source: B-INTACT screenshot.

2.5.2   Index of the extinction risk of species

The index of the extinction risk of species, based Isaac *et al.* (2007), is one of the indicators in the World Bank's open-access Terrestrial Biodiversity database, described above. The index is measured on a scale from 0 to 60. An example of the inclusion of the index of the extinction risk of species as ecological value weight into the B-INTACT assessment is shown in Figure 11.

Figure 11. Ecological value with index of the extinction risk of species

Source: B-INTACT screenshot.

2.5.3   Total endemicity score

The total endemicity score is based on the presence of species unique to the region in the grid cell. It is one of the indicators in the World Bank's Terrestrial Biodiversity open-access database, described above. The score is measured on a scale from 0 to 50. An example of the inclusion of the index of the extinction risk of species as ecological value weight into B-INTACT is shown in **Figure 12**.

Figure 12. Ecological value with total endemicity score

Source: B-INTACT screenshot.

PART 3. Qualitative approach

For the purpose of providing a thorough biodiversity impact appraisal, non-quantifiable impacts on biodiversity from project activities are assessed with a qualitative survey to complement the quantitative approach in the Biodiversity Integrated Assessment and Computation Tool. The qualitative check control of the biodiversity tool is a quick appraisal of topics including biodiversity hotspots and species diversity, overexploitation of resources, and agrobiodiversity. The qualitative analysis is divided into largely four sections. The first deals with the biodiversity sensitivity level of the project zone. The second section assesses the project's intended impact on the project zone's biodiversity sensitivity level. The third section addresses biodiversity management activities from the project, and the last section covers agrobiodiversity practices.

3.1 Project zone biodiversity sensitivity and project impact on biodiversity sensitivity

The aim of this section is to better frame the status quo sensitivity of in situ biodiversity. It takes into account the governance-regime taking place on the area of concern, possible further threats posed to present species, and the level of water stress. There is currently no consensus on a method to assess each component in a comprehensive method. However, disregarding these topics would distort the end analysis, and would not be reflective of the actual impacts put on biodiversity. A qualitative assessment is needed to better understand the scope of impact caused by the implementation of the project. Users are asked to make use of geo-spatialized data for enhanced accuracy.

Figure 13. Sections 1 and 2: project zone biodiversity sensitivity and project impact on biodiversity sensitivity

Source: B-INTACT screenshot.

Question 1. Is the project in a key biodiversity area?

Key biodiversity areas are sites that contribute significantly to the global persistence of biodiversity in different ecosystems (World Database of Key Biodiversity Areas 2019). This metric is defined by criteria such as threatened biodiversity, geographically restricted biodiversity and irreplaceability, among others. The map available to users is one co-developed by the United Nations Development Programme (UNDP) and United Nations Environmental Programme (UNEP), which allows a global scale view of different water stress indices, with precise, reliable and updated data resourceful for site-specific analysis. This variable allows a first glance at the potential project impacts on biodiversity by allowing users to compose with species present on-site and preliminarily assess a potential threat they will be subject to. Because of the specificities of species covered by the key biodiversity area metric, any implementation of human activities would put an additional pressure on their viability. Users are asked to answer a "yes/next to/no" format to assess the biodiversity sensitivity for the project.

In case the users respond with the answer "yes" or "next to", the tool further asks users to provide the project's intended impact on the key biodiversity area. A drop-down menu allows users to select either "positive","neutral", or "negative". This sub-question allows to provide for further necessary details on the intentions of the project, closely linked to its geographical situation, i.e. in a key biodiversity area. If the project's intention is to protect and generate a positive impact on biodiversity (answer "positive"), the pressure put on biodiversity created by the project will be lower than if the project had no intention to provide a positive impact on biodiversity, or a detrimental one.

Question 2. Is the project in a protected area?

In a bid to further understand the environmental conditions of the project location, the governance-regime dictating on-land practices highlights the local biodiversity vulnerability to additional disruption. As protected areas follow specific management practices, they bring into light the greater value of biodiversity under protection and are therefore internationally understood as great biodiversity conservation measures (Protected Planet 2019). Introducing human activities to a protected area would put a higher pressure on an already deemed vulnerable biodiversity system. To answer this question, users are asked to visit the Protected Areas map developed by Protected Planet Initiative based on the World Database on Protected Areas. The map relies on data gathered from different public and private sources, and updated monthly, unveiling the reliability of the map. As the dichotomy is easily made regarding geographical location, users answer a biodiversity sensitivity question under a "yes/next to/no" format.

In case the users input the answer "yes" or "next to", the tool further asks users to provide whether the project's intended impact on the protected area is either "positive","neutral", or "negative" This sub-question allows to provide for further necessary details on the intentions of the project, closely linked to its geographical situation, i.e. in a protected area. If the project's intention is to protect and generate a positive impact on protected areas, the pressure put on biodiversity created by the project will be lower than if the project had no intention to provide a positive impact on protected areas, or if its impact is a detrimental one.

Question 3. What is the share of threatened species (vulnerable, endangered, and critically endangered) among the total number of species within the project boundaries?

Developed by the IUCN, the Red List of Threatened Species has become the most trustworthy reference source on the conservational status of a variety of species. It is understood as a critical indicator of the health of the world's biodiversity. Users are asked to visit the IUCN's Red List to learn more about the presence of classified species on the project site. Users are able to draw geographical limits of their project, which will subsequently inform them on the presence of different categories of species. The question asks for the share of threatened species among the total number of species identified within the project boundaries, with species falling under "vulnerable," "endangered", and "critically endangered" classes designated as threatened species. The IUCN Red List automatically generates these shares when users draw a polygon of their area of concern. Introducing an agricultural project to an area showing risks of impacting endangered species unveils a potentially high sensitivity borne by the local biodiversity. This question comes with two sub-questions. The first asks users to provide the project's intended impact on threatened species: "positive", "neutral", or "negative". The second sub-question asks users whether the project increase or decreases the risk of introducing alien invasive species. Despite the advantages of species diversity, the presence of non-native species might pose an important threat to the local biodiversity. Indeed, non-native species can turn out to be invasive, decimating native species and threatening the local ecosystems balance. It is thus important to assess the possibility of introducing potentially invasive species to the project area. Users have the opportunity to visit, as a reference, the Global Register of Introduced and Invasive Species developed by the Invasive Species Specialist Group (ISSG) for the sake of achieving the Aichi Biodiversity Target 9, namely identifying invasive alien species that will be subject to special management practices.

Question 4. Does the project lie in a water stress area?

Assessing water use necessitates taking into account broader variables, such as time and space. Looking into project-site characteristics regarding the current availability of water resources allows users to better frame the future potential impacts of the projects on water availability. Although some indices have been made available to the public, such as the Water Availability Index or the Blue Water Sustainability Index, they only frame part of the issue the biodiversity module seeks to analyse. Respectively, only renewable sources of water and quantity of water without time or geographic specificities are taken into account. Moreover, data is not available worldwide, which makes the use of such indices irrelevant for a tool looking at project-level information.

The water-stress level of the project area can reflect an aspect of the area's level of biodiversity sensitivity. It is thus an important detail to assess in order to grasp the future estimated impacts compared to the current situation. Users should make use of the Baseline Water Stress map to answer the question. The use of this map, co-developed by UNDP and UNEP, allows a global scale view of different water stress indices, with precise, reliable and updated data for site-specific analysis. According to the Baseline Water Stress Index, users choose from the following drop-down menu options: "<10 percent water stress", "10–20 percent water stress", "20–40 percent water stress", "40–80 percent water stress", ">80 percent water stress" or "arid or low water use".

As a follow-up question, users are asked whether the project has a positive, neutral, or negative impact on the intensive use of water during the dry season, the use of unrenewable water resources (e.g. groundwater) and remote water sources. As water is an important natural resource in the preservation of local biodiversity, there is a need to assess its use regarding its period of use and origin of source. Assessing the intensive use of water during the dry season unveils important risks of water depletion, resulting in a negative impact on the local biodiversity. In the same logic, extracting water from unrenewable or remote sources not only increases the risk of water depletion but also increases the potential negative impact on biodiversity due to extraction and/or transportation infrastructures.

The first part of the quantitative analysis allows the users to have a broader idea of the state of local biodiversity, bringing light to the current potential risk they might already be bearing and if it is under some type of special management. The sensitivity identification questions are complemented with sub-questions that identify the intended impact of the project on the specified variables.

3.2 Biodiversity management activities and agrobiodiversity practices

Questions 5 to 16 deal with questions on biodiversity management activities and agrobiodiversity practices that may or may not be covered by the project. Users have the possibility to provide information on:

1) the applicability of the specific activity or practice
2) the amount invested in USD for this activity or practice
3) the "with-project" patches that are impacted by this activity or practice.

The biodiversity management activities and agrobiodiversity practices identified within B-INTACT are mostly limited to several land use categories. **Table 7** provides a summary of the land uses that are applicable for each of the biodiversity management activities and agrobiodiversity practices. For the ease of use, the tool automatically allows users to choose between the patches that may be relevant to the specific activities and practices in question, depending on the land use of the patch.

Table 7. **Summary of applicable land uses for biodiversity management activities and agrobiodiversity practices**

5. Does the project promote biodiversity buffers that increase landscape connectivity such as shelter belts, windbreaks, field herbaceous borders, etc.?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal)

Non-applicable land uses: Other (degraded)

6. Does the project promote measures to reduce and/or prevent human-wildlife conflict?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal), other (degraded)

Non-applicable land uses: None

7. Does the project reinforce forest governance and address illegal logging?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation

Non-applicable land uses: Grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal), other (degraded)

8. Does the project promote crop diversification, intercropping, and/or crop rotation practices?

Applicable land uses: Annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry

Non-applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), set-aside land, degraded land, other (nominal), other (degraded)

9. Does the project promote varietal diversity of crops, the utilization of traditional crops, and/or indigenous livestock breeds?

Applicable land uses: Grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry

Non-applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), set-aside land, degraded land, other (nominal), other (degraded)

10. Does the project promote integrated pest management (IPM)?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land

Non-applicable land uses: Other (nominal), other (degraded)

11. Does the project promote conservation agriculture?

Applicable land uses: Annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry

Non-applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), set-aside land, degraded land, other (nominal), other (degraded)

12. Does the project promote mixed farming systems and/or mixed home gardens?

Applicable land uses: Annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry

Non-applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), set-aside land, degraded land, other (nominal), other (degraded)

13. Does the project promote water harvesting and/or soil moisture retention methods?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal)

Non-applicable land uses: Other (degraded)

14. Does the project promote field margins (e.g. planting flower strips along field borders)?

Applicable land uses: Grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry

Non-applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, set-aside land, degraded land, other (nominal), other (degraded)

15. Does the project support in situ conservation of crop wild relatives (e.g. protection of natural or semi-natural areas where crop wild relatives grow)?

Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal)

Non-applicable land uses: Other (degraded)

16. Does the project support on-farm conservation of genetic resources (e.g. community seed banks) and/or the development of the local seed industry (e.g. promote the use of farm-saved seeds, support informal seed systems)?
Applicable land uses: Forest zone (default), forest zone (selective logging), forest zone (reduced impact logging), forest zone (clear-cut harvesting), forest plantation, grassland (non-degraded), grassland (moderately degraded), grassland (severely degraded), annual cropland (with any type of improvement), annual cropland (without any type of improvement), irrigated annual cropland, flooded rice, extensive agroforestry, intensive agroforestry, set-aside land, degraded land, other (nominal), other (degraded)
Non-applicable land uses: None

Source: Expert panel for B-INTACT and authors' own elaboration.

3.2.1 Biodiversity management activities

B-INTACT offers three questions on biodiversity management activities, which are represented in. A more detailed explanation on the meaning and use of the specific questions can be found below.

Figure 14. Section 3: project impact on biodiversity management activities

Source: B-INTACT screenshot.

Question 5. Does the project promote biodiversity buffers that increase landscape connectivity such as shelter belts, windbreaks, field herbaceous borders, etc.?

Ensuring connectivity within landscapes has been identified as a key component for biodiversity conservation. Connectivity can be defined as the degree to which landscapes and seascapes allow species to move freely and ecological processes to function unimpeded (UNEP, 2019). A local site concerned by a development project needs to be considered as part of a wider network composed of habitat patches and characterized by biotic interactions and flows of species and populations. Insufficient consideration of habitat networks can lead to irreversible effects on biodiversity. In the logic of assessing the easy flow of species between different landscape areas, the question relies on the concept of landscape connectivity. It combines landscape attributes with information on species dispersion, considers the movement capacities of species and the landscape's resistance to such movements. Promoting biodiversity buffers goes beyond a mere land fragmentation quantitative assessment, as it informs on the potential positive impacts engendered by such practice. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) with the project on biodiversity buffer promotion activities. Additionally, users can select which "with-project" patches are impacted by the project in relevance to biodiversity buffer promotion.

Question 6. Does the project promote measures to reduce and/or prevent human-wildlife conflict?

Human and wildlife conflict is defined by FAO as any human and wildlife interaction which results in negative effects on human, social, economic, or cultural life, on wildlife conservation, or on the environment. Human and wildlife conflicts heavily undermine the in-situ biodiversity state, and pose a great threat to both human and natural populations. Ensuring that, through the implementation of an agricultural development project, human and wildlife conflits are decreased and do not undermine the state of local biodiversity, is crucial when assessing the efficiency of biodiversity conservation measures. By guaranteeing to reduce wildlife conflicts with agricultural activities, an agricultural project makes great effort in minimizing its impact on local biodiversity. The Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) with the project on

wildlife conflict-decreasing activities. Additionally, users can select which "with-project" patches are impacted by the project in relevance to the reduction of wildlife conflict.

Question 7. Does the project reinforce forest governance and address illegal logging?

The consideration of different natural resources is crucial in order to reflect and assess local conditions as accurately as possible. As natural habitats, shelters from predators or source of food for a variety of species, trees and forest play a major role in biodiversity conservation. Illegal extraction of wood from its original sources can negatively affect the local biodiversity, thus the relevance of assessing the existence and scope of implementation of sustainable forest governance. Disregarding illegal logging practices in the project area would have an indirect harmful effect on the local biodiversity. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) with the project on forest governance reinforcement and the reduction of illegal logging. Additionally, users can select which "with-project" patches are impacted by the project with regards to these biodiversity management activities.

3.2.2 Agrobiodiversity practices

Because of the broad aspects that the concept of agrobiodiversity encapsulates, there is no comprehensive tool to reflect the complexities of the topic. Agrobiodiversity is defined by FAO (2004) as the diversity of crops and their wild relatives, trees, livestock, fish, microbes and other species that contribute to agricultural production. Agricultural biodiversity is the outcome of the interactions among genetic resources, the environment and the management systems and practices used by farmers. This is the result of both natural selection and human inventions developed over millennia.

Figure 15. Section 4: agrobiodiversity practices

Source: B-INTACT screenshot.

With the objective to capture the essence of the concept, the qualitative assessment extends over nine questions, stated below.

Question 8. Does the project promote crop diversification and intercropping practices?

Promoting crop diversification unveils the advantages of introducing different species suited to the local context, thus increasing diversity present on the project location. Despite the economic advantages of crop diversification, it also allows the local biodiversity to become more resilient towards risks and shocks, and to avoid the harmful effects of mono-cropping. Intercropping may also provide clear advantages for the production, reinforcing ecosystem services provided by the local biodiversity. Assessing the promotion of such practices discloses the positive advantages they could yield on biodiversity. Along with the following question, the agrobiodiversity topic touches upon the matter of land heterogeneity and the related impacts on biodiversity. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on crop diversification and/or intercropping practices. Additionally, users can select which "with-project" patches are impacted by the project in relevance to the promotion of crop diversification and intercropping practices.

Question 9. Does the project promote varietal diversity of crops, the utilization of traditional crops, and indigenous livestock breeds?

In a bid to enhance the biodiversity state of the area under concern through genetic diversity, making use of traditional crops, indigenous livestock breeds and local seeds works towards the conservation of the local biodiversity and of native species. The usage of traditional crops, indigenous livestock breeds and local seeds would strengthen the local biodiversity, preventing them from disappearing in favor of "foreign" species. Their promotion through the implementation of a project would positively influence the local state of biodiversity, thus the relevance of assessing their use. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of varietal diversity of crops, the utilization of traditional crops, and/or indigenous livestock breeds. Additionally, users can select which "with-project" patches are impacted by the project in relevance to the promotion of the practices stated above.

Question 10. Does the project promote integrated pest management (IPM)?

As chemical pollution is an important driver of biodiversity loss, assessing the use of alternative pest control and pest management is a necessary point when looking at the biodiversity impact of the implementation of a project. An excessive use of chemical-based plant protection material would have damaging effects on the surrounding biodiversity, increasing threats and pressures put on local species. In this regard, assessing the use of sustainable or alternative pest management methods constitutes a substantial part of a project's biodiversity impact assessment. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of integrated pest management practices. Additionally, users can select which "with-project" patches are impacted by the project regarding the promotion of integrated pest management.

Question 11. Does the project promote conservation agriculture?

Soils are home to over a quarter of all living species on earth (EC, DG ENVI 2010). Soils are also the core of agriculture and forestry: healthy soils generate quality yields and ensure a viable production system. However, conventional agricultural practices have been overlooking such principle and have introduced an agricultural model with high soil disturbance, e.g. mono-cropping schemes, which have adverse impacts on biodiversity worldwide. Introducing or further promoting conservation measures reduces pressures put on local biodiversity by human activities. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of conservation agriculture. Additionally, users can select which "with-project" patches are impacted by the project with respect to the promotion of conservation agriculture practices.

Question 12. Does the project promote mixed farming systems and/or mixed home gardens?

Mixed agro-ecosystems integrating crop and animal production can take many forms and unveil significant advantages for the local biodiversity, bridging the gaps of the current conventional degrading farming systems. The separation of animal production and crop production has had adverse effect on biodiversity, resulting in increased water pollution and increased dependence on external inputs. The consequences on the longer term have undermined agriculture's resilience to climate change and permanently damaged the biodiversity state. Introducing or further promoting the implementation of mixed agro-ecosystems in agriculture not only decreases the pressure put on the local biodiversity, but also conveys a sustainable implementation of biodiversity conservation measures. Users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of mixed farming systems and/or mixed home gardens. Additionally, users can select which "with-project" patches are impacted by the project with regards to the promotion of the mixed systems stated above.

Question 13. Does the project promote water harvesting and soil moisture retention methods?

Excessive water use has adverse effect on biodiversity, as stated throughout the "Overexploitation of natural resources" topic. As sustainable use of water resources need a comprehensive approach, the biodiversity assessment should look at the origin of water extracted (subquestion of Question 4) as well as the on-site usage and methods to further increase efficient management of water resources. Introducing or further promoting water harvesting and soil moisture retention methods reduces water mismanagement pressures on the local biodiversity and increases the agricultural system's resilience to potential risks and shocks. Examples of water harvesting and soil moisture retention methods include the collection and concentration of various forms of runoff water, such as through retention ditches, contour farming, contour furrows, stone lines, grass strips, planting pits, mulching, earth basins, etc. Such actions would contribute to increasing biodiversity conservation measures. Depending on the extent of actions taken to implement such practices, users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of water harvesting and soil moisture retention methods. Additionally, users can select which "with-project" patches are impacted by the project regarding the promotion of the practices stated above.

Question 14. Does the project promote field margins (e.g. planting flower strips along field borders)?

Field margins are understood to be agricultural practices which enhance on-farm biodiversity and work towards natural resources (i.e. soil and water) conservation. They can be understood as multifunctional because of their capacity to participate in a plethora of biodiversity conservation measures, while still supporting agricultural production. Field margins protect ex-situ biodiversity by providing a barrier with in-situ practices. As they are on-farm embedded practices, they may take various forms, and engage in environmental measures adapted to the local context. An example of a multifunctional field margin could be the introduction of wildflowers, which will in return become pollen and nectar sources for pollinators and seed sources for birds. Field margins can thus be highlighted as agricultural practices that have a positive biodiversity impact. Their promotion through the implementation of an agricultural project puts forward the positive biodiversity impact that could emanate from it. Depending on the extent of actions taken to implement such practices, users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the promotion of field margins. Additionally, users can select which "with-project" patches are impacted by the project with respect to the promotion of field margins.

Question 15. Does the project support in situ conservation of crop wild relatives (e.g. protection of natural or semi-natural areas where crop wild relatives grow)?

Crop wild relatives are defined as wild species that are found in natural and semi-natural ecosystems, and are critical components of plant genetic resources for food and agriculture (Kell and Maxted, 2009). They present an important potential of genetic diversity, and are understood as vital resources for future crop improvement by presenting traits beneficial to crops, such as pest or disease resistance, yield improvement or stability. Because of their constant evolution as an adaptation to their environment, crop wild relatives are a component of natural ecosystems that cannot effectively be maintained ex-situ only (Kell and Maxted, 2009). Despite their manyfold assets, they are subject to great threats because of an increasingly unstable environment due to climate change and unsustainable agricultural practices. Moreover, their conservation has been highly neglected because of their lack of "rareness" or high threat they were subject to, as highlighted through ecological conservation focus, and because they don't belong to crop species, falling short from agricultural conservation measures. By promoting in-situ conservation of crop wild relatives, an agricultural project not only enhances local biodiversity and improves its state, but also ensures some protection and resilience to future threats (i.e. climate change, rapid urbanization, habitat fragmentation, intensification of agricultural practices). In situ conservation of crop wild relatives practices present positive biodiversity conservation measures. Depending on the extent of actions taken to implement such practices, users are asked to answer either "Yes" or "No" to

the question and provide the total amount invested (USD) from the project on the support of in situ conservation of crop wild relatives. Additionally, users can select which "with-project" patches are impacted by the project with regards to the support of in situ conservation of crop wild relatives.

Question 16. Does the project support on-farm conservation of genetic resources (e.g. community seed banks) and/or the development of the local seed industry (e.g. promote the use of farm-saved seeds, support informal seed systems)?

Genetic diversity of crops is increasingly threatened, and current trends have highlighted the adverse effect of diminished genetic diversity in foods and cultivars. Diets and yields are directly impacted by a reduced genetic diversity of crops, unveiling the negative and multifold effects raised by the issue. The fundamental objective of genetic resources conservation is the maintenance of broad based genetic diversity within each of the species (i.e., intra-specific genetic diversity) (International Board for Plant Genetic Resources, 1991). In-situ conservation allows conservation of genetic diversity to take place in suited ecosystems, and locally embedded infrastructures help to preserve the original characteristics of habitats. Efforts towards genetic diversity conservation are part of biodiversity conservation measures, and allow for more resilient and enhanced local biodiversity. Supporting on-farm conservation of genetic resources and/or the development of local seeds infrastructures through the implementation of an agricultural project results in positive biodiversity impacts. Depending on the extent of actions taken to implement such practices, users are asked to answer either "Yes" or "No" to the question and provide the total amount invested (USD) from the project on the support of on-farm conservation of genetic resources and/or the development of the local seed industry. Additionally, users can select which "with-project" patches are impacted by the project regarding the support of on-farm conservation of genetic resources and/or the development of the local seed industry.

PART 4. Computing B-INTACT with EarthMap

EarthMap is a tool for quick historical environmental and climate analysis based on Google Earth Engine and developed with the support of the Government of Germany through the International Climate Initiative (IKI) from the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (EarthMap, 2021).

The B-INTACT collaboration with EarthMap goes beyond the scope of simply accessing data, as described in Part 1 and Part 2 of these guidelines. Together with the EarthMap team from FAO's Office of Climate Change, Biodiversity and Environment, the B-INTACT experts have developed a new feature within the Biodiversity Integrated Assessment and Computation Tool to automatically generate patch-level information on the land use, fragmentation group and area based on geospatial land use data. In other words, it is now possible to do a first biodiversity assessment of the baseline situation within a timeframe of merely a few minutes. This responds to the needs to provide a scientifically sound, yet time- and cost-efficient biodiversity assessment.

In what follows, EarthMap and its new feature is explained in detail.

4.1 Introduction to EarthMap

As a first step, the user must access the EarthMap platform on **earthmap.org**. The user will be redirected to EarthMap's landing page as shown in **Figure 16**.

Figure 16. EarthMap landing page
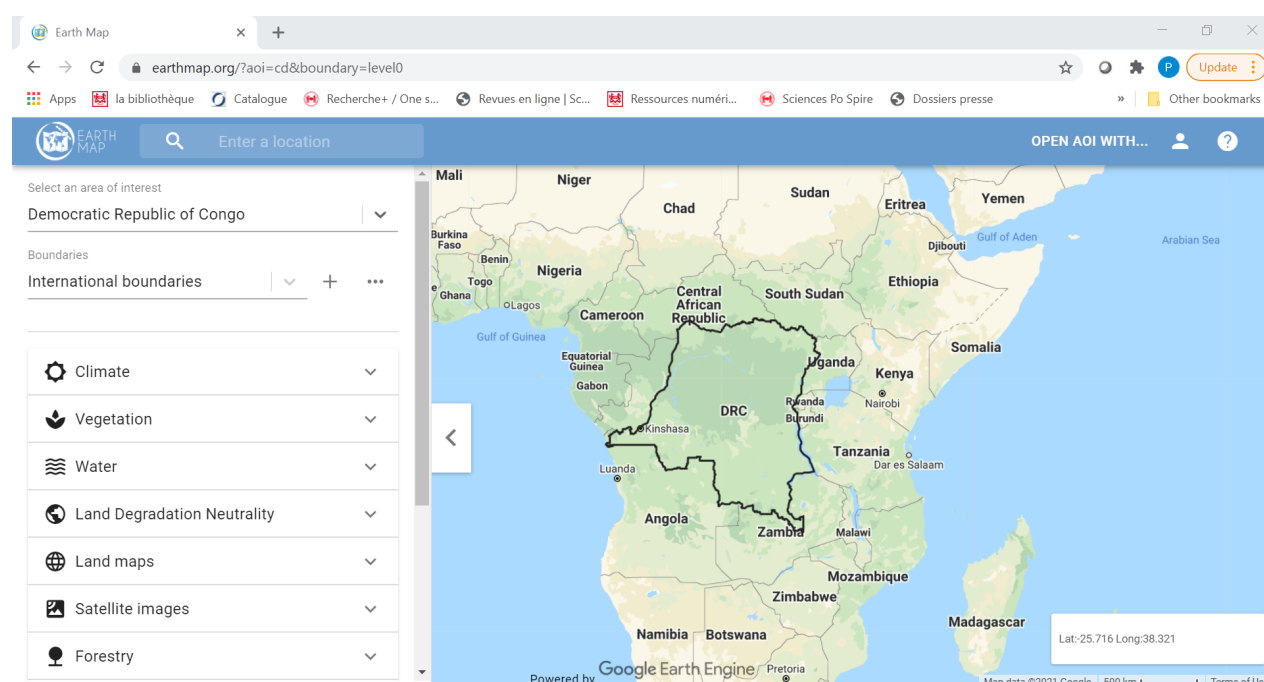
Source: EarthMap screenshot.

After selecting an area of interest and its boundaries,[1] the user will see the different categories, covering data on the climate, vegetation, water, land degradation neutrality, land maps, satellite images, forestry, fires, geophysical factors, geosocial factors, biodiversity and the soil.

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[1] Note that the user also has the option to upload a KML file or draw an area of interest as project boundary. To do this, the user can specify the larger area of interest, and then click on the + sign (on the right of the boundary field).

EarthMap now offers users the possibility to (1) visualize the different layers from the menu on the left (as shown in **Figure 17** for the ESA CCI LC layer) or (2) click on the area of interest inside the map and access the historical data of the various metrics. For this purpose, the user can select the metric of interest and the preferred temporal unit and/or range to process the data. Once, the data is processed, the data can be viewed in the console (to the right) or downloaded as Comma Separated Values (CSV) file (as shown in **Figure 18**).

Figure 17. Visualization of the land cover CCI layer in EarthMap
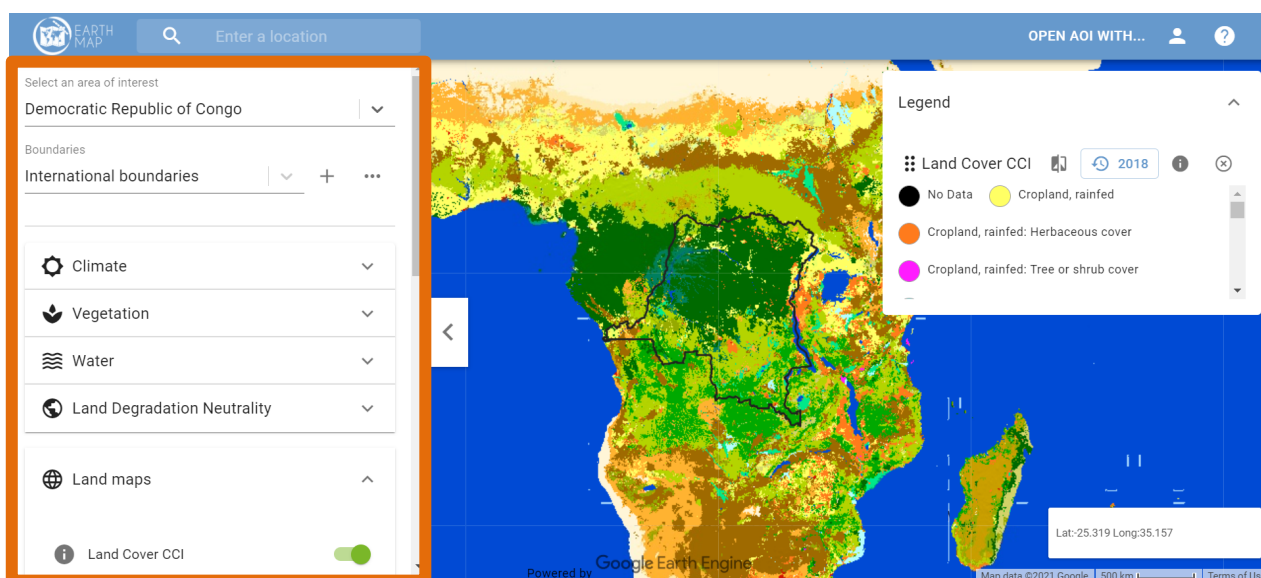
Source: EarthMap screenshot.

Figure 18. Accessing the historical data of the area of intervention in EarthMap
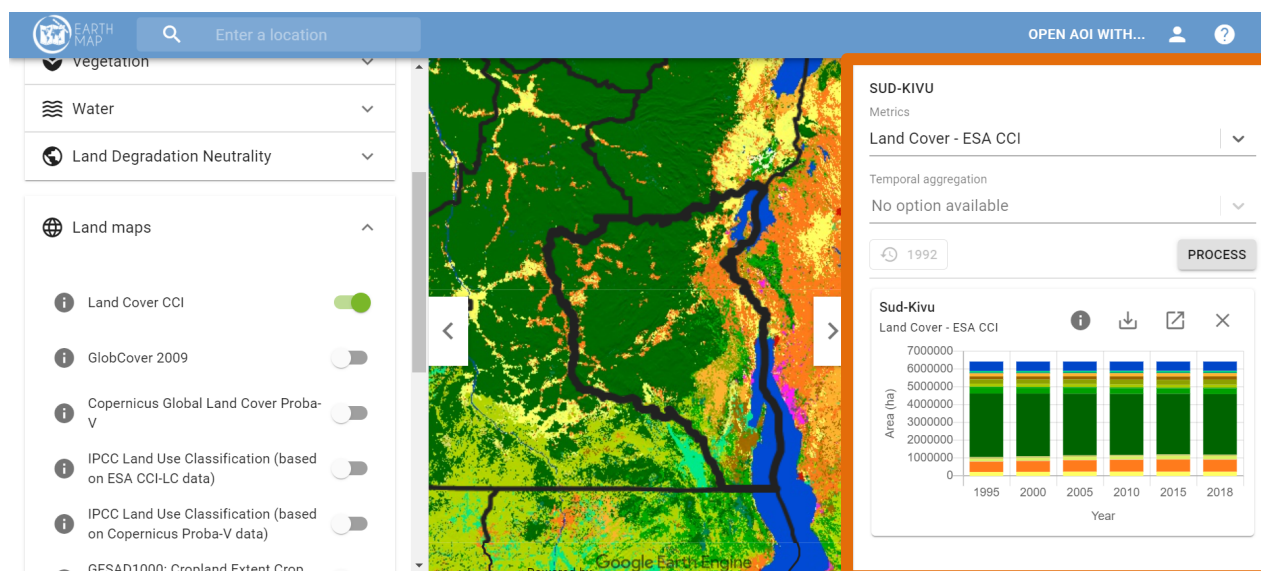
Source: EarthMap screenshot.

4.2 Using EarthMap for a B-INTACT assessment

EarthMap offers the option to download a dedicated file for the Biodiversity Integrated Assessment and Computation Tool, which automatically generates patch-level information on the land use, fragmentation group and area. By selecting an area of interest of the size of a district, the user can select "B-INTACT" among the different metrics listed in the drop down menu within the console. EarthMap will generate an Excel file for download. **Figure 19** shows the EarthMap B-INTACT output for the Corail district in Haiti.

Figure 19. EarthMap download for B-INTACT
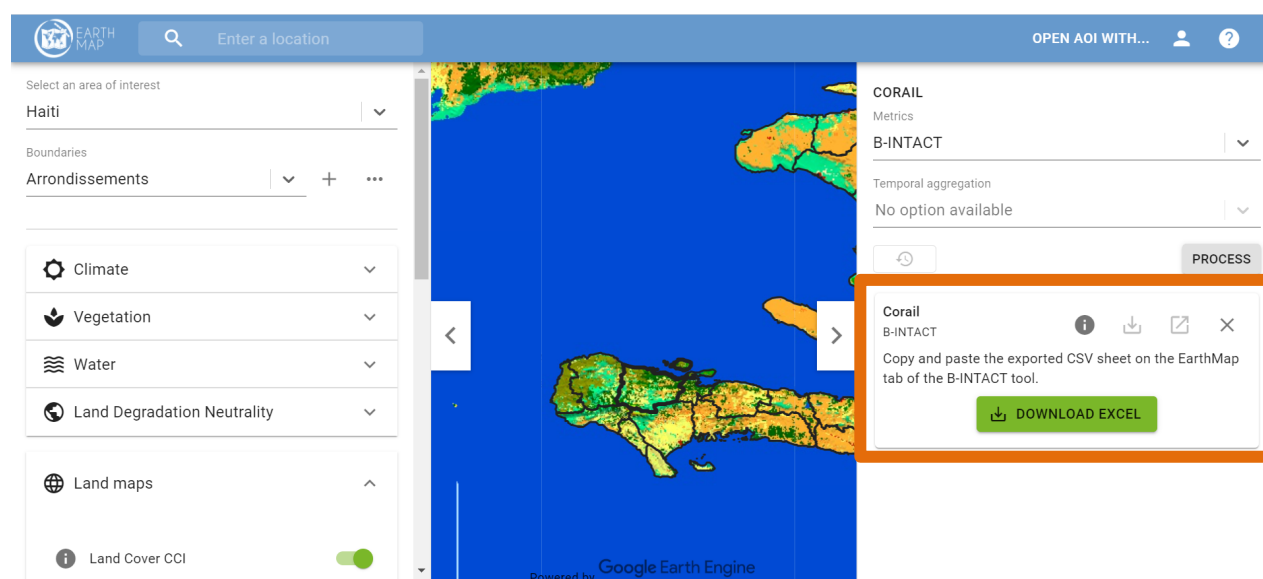
Source: EarthMap screenshot.

When opening the EarthMap output for B-INTACT, the user will see an Excel table as presented in **Figure 20**. The Excel file is divided into two sheets, with the first one representing data at patch level (including, among others, the land use, area and fragmentation group) and the second one showing project-level data (including, among others, mean annual temperature, mean annual precipitation and potential evapotranspiration).

Figure 20. EarthMap output for B-INTACT

Source: EarthMap output screenshot.

Figure 21. EarthMap sheet within B-INTACT
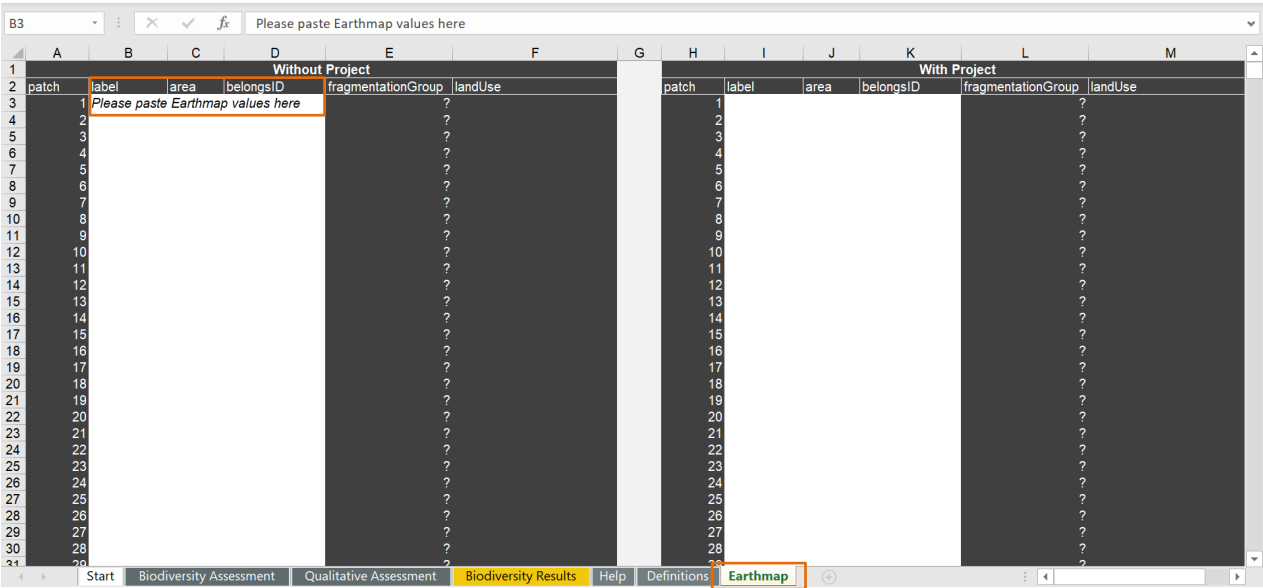
Source: B-INTACT screenshot.

The Biodiversity Integrated Assessment and Computation Tool has a dedicated sheet called EarthMap. The user can now copy the values from the column areaHa, belongsId and label within the Earthmap output and paste them into the "Without Project" label, area and belongsID cells, respectively, within the sheet in B-INTACT. An example of the Corail district is shown in **Figure 22**.

Once the values are pasted to the EarthMap sheet, the Biodiversity Integrated Assessment and Computation Tool automatically fills all relevant cells of the baseline biodiversity assessment.

Figure 22. Filled EarthMap sheet within B-INTACT
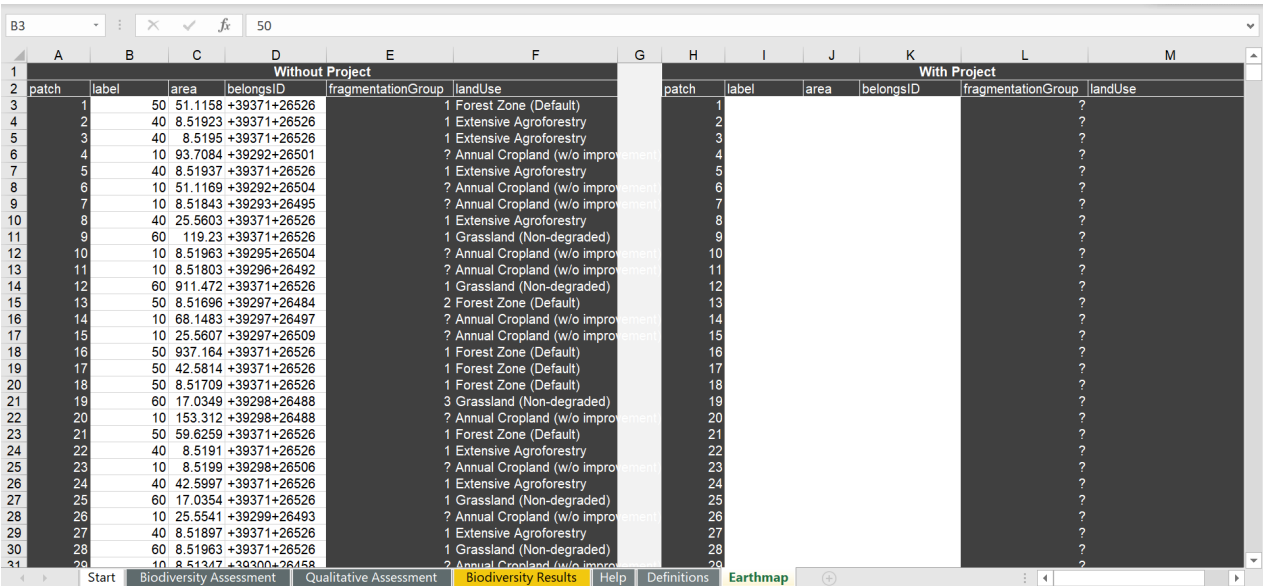
Source: B-INTACT screenshot.

Figure 23. B-INTACT results from the automated EarthMap assessment

Source: B-INTACT screenshot.
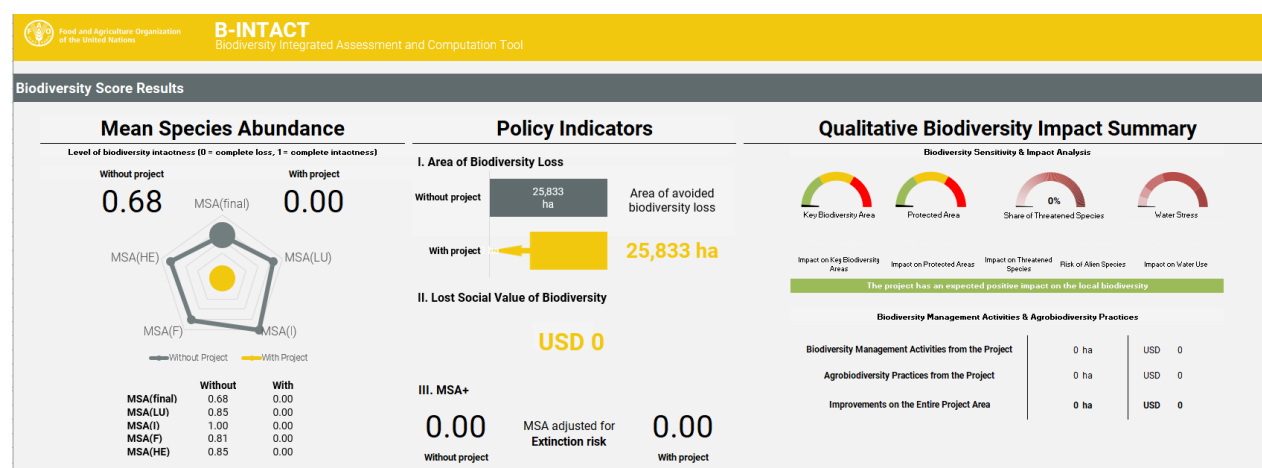
PART 5. B-INTACT results

The quantitative and qualitative results from the B-INTACT impact appraisal is provided in a separate sheet called "B-INTACT results". This sheet is divided into three sections.

The first section focuses on the results reflecting the level of biodiversity intactness without and with the project for the duration of the project, including both the implementation and capitalization phase, which generally amounts to 20 years.[2] As shown in **Figure 24**, users are provided with the aggregate MSA scores for both without and with the project, along with a radar chart and a table indicating the individual MSA scores of land use, infrastructure, fragmentation, and human encroachment. The MSA scores range from 0 to 1, with 0 representing complete species loss, and 1 representing complete species intactness. As an example, if the without project MSA is 0.33 and the with project MSA is 0.42, this translates into a 33 percent of expected species intactness without the project, and 42 percent of expected species intactness with the project in the span of 20 years. The radar chart and table allow users to understand from which pressure the aggregate MSA of both their without project and with project scenarios are most affected. For example, in the example below, the impact from fragmentation is the most important pressure in both the without and with project scenarios.

Figure 24. Results section 1: level of biodiversity intactness
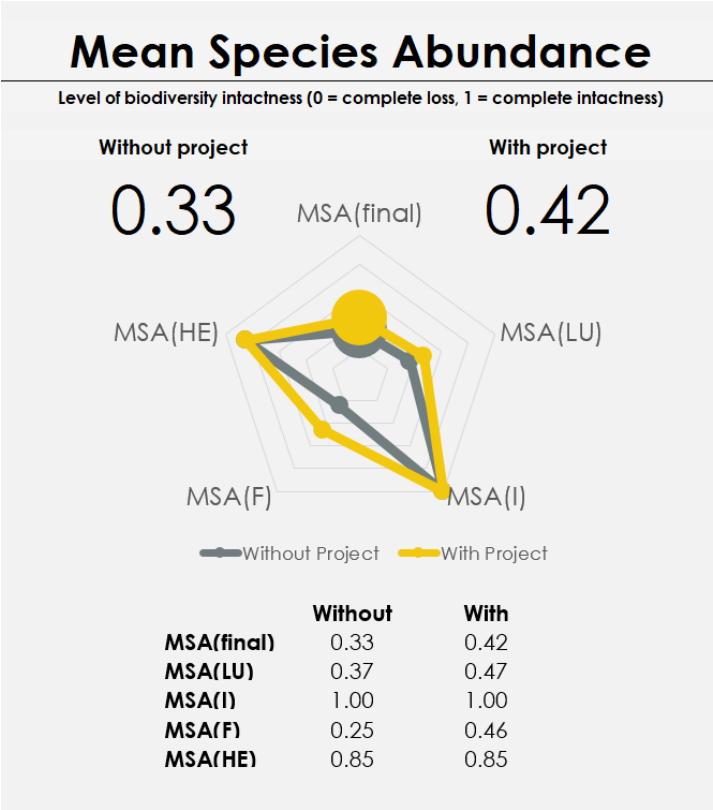
Source: B-INTACT screenshot.

The second section displays a set of policy indicators, as shown in **Figure 25**. These indicators may be useful in providing additional information that is formulated in an easily comprehendible manner for decision-makers.

The first indicator is the area of biodiversity loss. This is the surface area-equivalent of the MSA metric and is derived by multiplying the total project area with the (1-MSA) of the without and with project scenarios. The figures displayed here can be interpreted as the hectares of biodiversity loss, or the equivalent total area of biodiversity loss that one would expect from a conversion of the area from an

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[2] Twenty years is the IPCC reference for carbon-balance appraisals. This period is also considered for B-INTACT.

undisturbed ecosystem (e.g. natural forest) into a completely artificial one (e.g. concrete parking lot). Users are also provided with a bar chart representing the different areas of potential biodiversity loss both without and with the project, along with the difference between the two which represents the area of avoided biodiversity loss due to the project.

The second indicator is the added social value of biodiversity from the projects. This indicator may supplement the social cost of carbon from (avoided) emissions that is frequently reported by project-implementing entities and investment institutions. It may also be considered in the economic and financial analysis.

Finally, if the users selected "Yes" for the question "Include weights for ecological value?" and input data on either vulnerability, extincted risk, or endemicity for each patch, the MSA adjusted for ecological value, namely the MSA+ will appear under the added social value of biodiversity as the third policy indicator. MSA+ can be useful for project designers when comparing the biodiversity impact of projects with similar activities but different project sites.

Figure 25. Results section 2: policy indicators
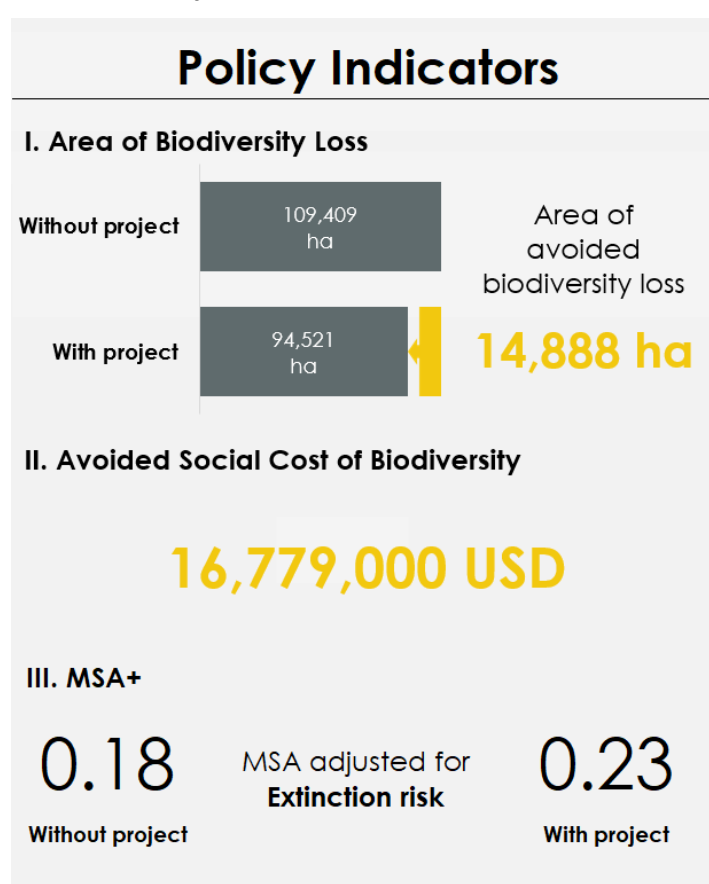
Source: B-INTACT screenshot.

The third section reveals the results from the qualitative assessment, as can be seen from **Figure 26**. The first row consists of four speedometer charts with indicators that reflect the level of biodiversity sensitivity within the project zone. Below each chart is a color-coded indication of whether the project has an intended negative (red), neutral (yellow), or positive (green) impact on elements of local biodiversity. An overall expected impact on local biodiversity derived from the individual impacts on key biodiversity areas, protected areas, threatened species, risk of alien species, and water use is displayed as a sentence, also color-coded as above. Aggregated in broader topics, users have the opportunity to better frame which matters should be addressed differently in case of a neutral or negative impact on biodiversity and enhanced by the implementation of the project. Following this, the results provide a summary of the total number of hectares that are impacted by biodiversity management activities and agrobiodiversity practices from the project, and the amount invested into these activities and practices.

Figure 26. Results section 3: qualitative biodiversity impact summary
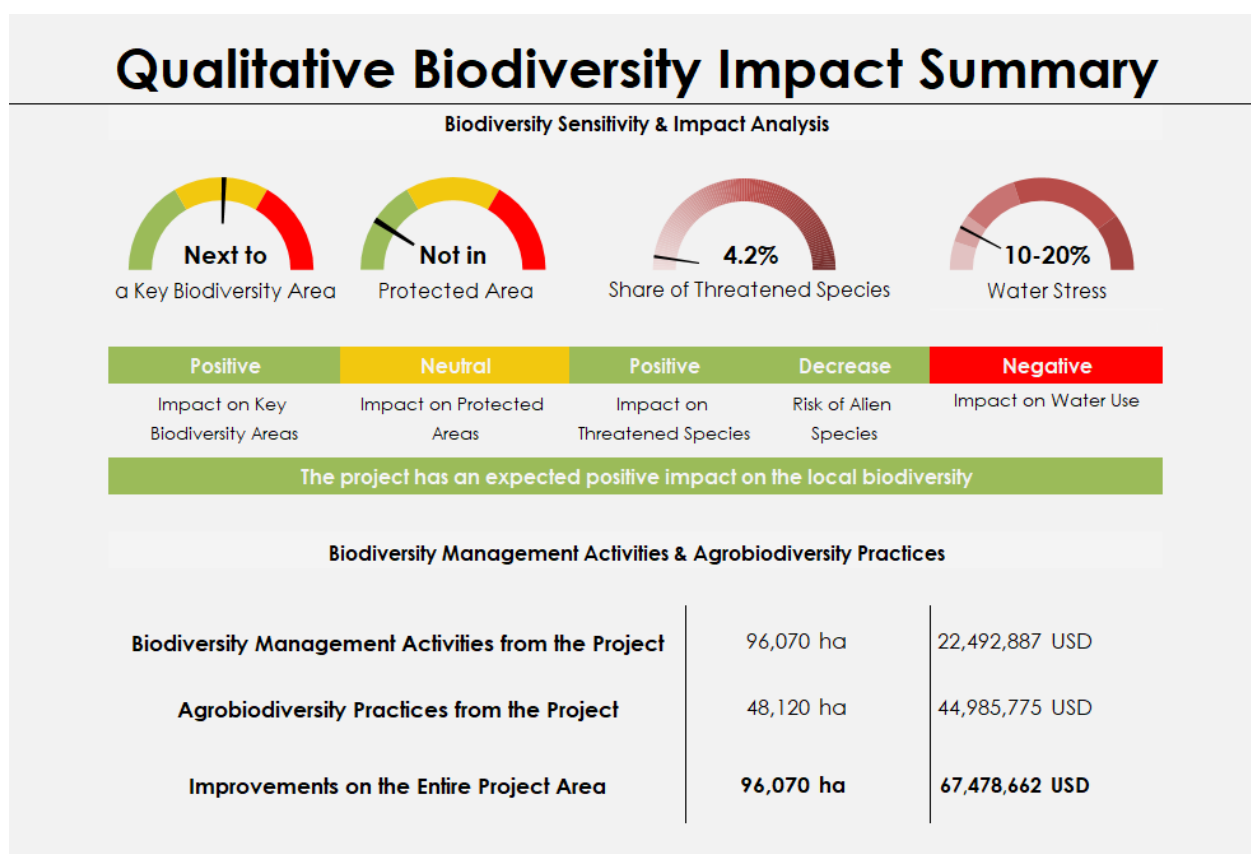
Source: B-INTACT screenshot.

Together, the quantitative and qualitative analyses target all issues relevant to biodiversity pressures and provide a reliable biodiversity impact assessment to better inform decision-making. Users are encouraged to take a screenshot of the results sheet to add in their project assessment reports.

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Glossary

Agrobiodiversity	The diversity of crops and their wild relatives, trees, livestock, fish, microbes and other species that contribute to agricultural production. Agricultural biodiversity is the outcome of the interactions among genetic resources, the environment and the management systems and practices used by farmers. This is the result of both natural selection and human inventive developed over millennia (FAO, 2016)
Alien invasive species	Alien invasive species are plants or animals that are not naturally found in an area, the accidental or deliberate introduction of which has or is likely to cause economic or environmental harm (FAO, 2018)
Buffer zone	A strip of living trees and/or shrubs maintained mainly to provide shelter or to mitigate the impacts of actions on adjacent lands, to enhance aesthetic values, or as a best management practice (FAO, 2010)
Biodiversity hotspot	Areas that support natural ecosystems that are largely intact and where native species and communities associated with these ecosystems are well represented. They are also areas with a high diversity of locally endemic species, which are species that are not found or are rarely found outside the hotspot (FAO, 2016)
Carbon sequestration	The process of increasing the carbon content of a reservoir other than the atmosphere (FAO, 2015)
Conservation agriculture	An approach characterized by three linked principles, namely, continuous minimum mechanical soil disturbance; permanent organic soil cover; and diversification of crop species grown in sequences and/or associations (FAO, 2013)
Conservation of genetic resources	The maintenance of broad based genetic diversity within each of the species (i.e., intra-specific genetic diversity) (International Board for Plant Genetic Resources, 1991)
Crop diversification	Species diversification through varied crop associations and/or rotations (involving annual and/or perennial crops including trees) (FAO, 2013)
Crop wild relatives	Wild species that are found in natural and semi-natural ecosystems, and are critical components of plant genetic resources for food and agriculture (Kell and Maxted, 2009)
Ecological value	Non-monetary assessment of ecosystem integrity, health, or resilience, all of which are important indicators to determine critical thresholds and minimum requirements for ecosystem service provision (The Economics of Ecosystems and Biodiversity, 2010)
Ecosystem services	The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits and supporting services, such as the nutrient cycling that maintains the conditions for life on Earth (FAO, 2013)
Ecological footprint	The impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated (WWF, 2019)

Environmental action plan	Part of a formal project environmental assessment, this plan outlines feasible and cost-effective measures which may reduce potentially significant adverse environmental impacts to acceptable levels. It should provide details of proposed work programs and schedules to ensure that the proposed environmental actions are in phase with engineering activities throughout preparation (FAO, 2011)
Food system	The entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products (FAO, 2019)
Habitat fragmentation	Set of mechanisms leading to the discontinuity in the spatial distribution of resources and conditions present in an area at a given scale that affects occupancy, reproduction, and survival in a particular species (FAO, 2013)
Human encroachment	Anthropogenic activities in otherwise natural areas, comprising of hunting, food and fuel gathering, recreation, and human settlements.
Human-wildlife conflicts	Any human and wildlife interaction which results in negative effects on human social, economic, or cultural life, on wildlife conservation, or on the environment (FAO, 2012)
Illegal logging	Illegal logging takes place when timber is harvested, transported, bought or sold in violation of national laws (FAO, 2003)
Indigenous livestock breeds	A breed of livestock, including cattle, camels, sheep, goats, pigs and poultry, which has been in the country for a sufficient time to be genetically adapted to one or more of traditional production systems or environments in the country (FAO, 2001)
Integrated pest management	It is the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keeps pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO, 2018)
Intercropping	Growing two or more crops simultaneously on the same field (FAO, 2018)
Mixed farming system	Systems in which livestock keeping is integrated with other agricultural activities, together forming a whole (FAO, 2015)
Multifunctional field margins	Agricultural practices which participate in a plethora of biodiversity conservation measures, while still supporting agricultural production (Bioversity International, 2018)
Nitrogen deposition	It is the input of nitrogen balance from the atmosphere into the soil-plant system. It determines productivity of a cropping system without Nitrogen fertilizers and inputs. Nitrogen deposition impacts air pollution and ecosystem health. It fluctuates over time (Eickenscheidt *et al.*, 2011)
Species abundance	The number of individuals from one species found in an ecosystem/sample area.
Species richness	A measure of the number of different species in an area (FAO, 2010)
Traditional crop	Traditional crops are crops that have been grown for a long time by local communities and that are well adapted to the local agro-climatic conditions (FAO, 2018)

Varietal diversity	Diversification through multiple varieties of a single type of crops (e.g. producing Red Delicious, Fuji and Gala varieties of apples)
Water harvesting and soil moisture retention methods	The collection and concentration of various forms of runoff water, such as through retention ditches, contour farming, contour furrows, stone lines, grass strips, planting pits, mulching, earth basins, etc. (FAO, 2019)

Annex 1. Review of existing metrics review of existing biodiversity impact assessment methods

A.1.1 Metrics

The literature highlights two metrics widely used to attribute a value to biodiversity: Potentially Disappeared Fraction of Species (PDF) and Mean Species Abundance (MSA).

PDF takes a focus at the species level, often expressed as $PDF.m^2.yr$, and interpreted as the fraction of species that has a high probability of non-occurrence in a region due to unfavourable conditions. The metric does not differentiate between the global and local level. It expresses the damages made on biodiversity at the end point of an activity pursued, acting as an impact indicator.

On the other hand, MSA acts as a state indicator by highlighting the range of impact on an ecosystem, and varies between 0 percent and 100 percent (or 0 and 1), where:

- MSA = 100 percent highlights an undisturbed ecosystem where all original species remain;
- MSA = 0 percent highlights a destroyed ecosystem with no original species left.

This metric is most relevant at a global scale: considering biodiversity in a specific and unique context is harder to achieve. Additionally, this metric does not seize potential species extension.

Despite the specific advantages and drawbacks of both metrics, it appeared more relevant for B-INTACT to use MSA, as more pressure impact relationships that are relevant to AFOLU activities have been readily defined by credible sources and the data is spatialized. Moreover, with the use of the MSA metric, different weights could be given to different ecosystems, depending on priorities emanating from a specific context, a useful potential for a globally developed tool applied at local levels.

A.1.2 Tools and methodologies based on the MSA metric

Following the choice of existing metrics endorsed by the literature, different methodologies and models exist, each with different concerns and goals concerning biodiversity assessment. Each has a different focus and reflects different dimensions of biodiversity assessment. Given the decision to make use of the MSA metric, the number of existing and accessible tools or models is fairly restricted. Widely known tools and models include the GLOBIO model developed by PBL, the Global Biodiversity Score (GBS) developed by CDC Biodiversité, Biodiversity Impact Metric developed by the Cambridge Institute for Sustainable Leadership (CISL), the Biodiversity Impact Index developed by the LIFE Institute, the Product Biodiversity Footprint developed by I-CARE and Sayari, the Living Planet Index developed by the World Wide Fund for Nature (WWF) and Zoological Society of London (ZSL), the Species Threat Abatement and Recovery (STAR) tool developed by the International Union for Conservation of Nature (IUCN), the Biodiversity Footprint developed by Plansup, the Biodiversity Footprint Approach developed by ASN Bank, and the Agrobiodiversity Index developed by Bioversity International, among others.

A summary of the objective and methodology of some selected tools and models, along with how they relate to B-INTACT, can be found below.

The GLOBIO model assesses impacts of human-induced biodiversity-loss drivers in past, present and future scenarios. It is based on causal-effect relationships, derived from the literature. To use GLOBIO, no detailed species data are needed. Instead, the model uses spatial information on environmental drivers as input. This input is mainly derived from the Integrated Model to Assess the Global Environment (IMAGE, an ecological-environmental model framework that simulates the environmental consequences of human activities worldwide).

This model is widely used by other tools cited above as it allows for global and specialized analyses while integrating ordinary biodiversity and using a widely agreed-on metric. GLOBIO is thus a consensual tool that has been endorsed by other developers concerned with biodiversity assessment.

The Global Biodiversity Score (GBS) is designed to provide an overall and synthetic vision of the biodiversity footprint of economic activities. When ran, it allows an entity to assess its potential impact

on biodiversity, and what realms generate the most harmful and/or positive impacts. It can be estimated in a two-step process:

1. The pressures caused by specific economic activities on biodiversity have to be quantitatively assessed. To analyze the value chain, the GBS™ methodology mainly uses the Exiobase matrix-based input-output model and direct data on pressures when available.

2. The impacts of these pressures on ecosystems have to be estimated. This last step relies on the GLOBIO model which is based on pressure-impact relationships. Modelled results of GLOBIO are used to estimate average industry pressures (and impacts) when real data is not available (= 'default assessment'). When real data on pressures is available, it is combined to the pressure-impact relationships provided by GLOBIO to conduct a 'refined assessment'.

The GBS relies on a methodology fitting to what B-INTACT intends to highlight. Although the GBS allows for the calculation of coherent estimates of the biodiversity impact by covering most drivers of biodiversity-loss, the tool is not user-friendly and requires special knowledge to be run, coupled with the lack of instantaneity regarding results.

In a bid to better frame business activities impact on biodiversity, the Cambridge Institute for Sustainability Leadership has developed the Healthy Ecosystem metric. It is broken down into three components, namely biodiversity, soil and water. The metric allows for a comparison in space and time of the quality and quantity of biodiversity impacted by business activities. The Biodiversity sub-component relies on the Biodiversity Intactness Index approach, refined to be able to work with more localized data. Although the metric touches upon the same components of the Biodiversity Integrated Assessment and Computation Tool, it is specifically tailored for value-chain analysis and thus agri-businesses, and assesses the whole production process. Such aim differs from the biodiversity assessment in B-INTACT, which seeks to assess the biodiversity impact generated by investments in the AFOLU sector from financial institutions.

The LIFE index was developed with the goal of guiding and acknowledging businesses organizations that promote effective Natural Capital conservation actions, contributing to the maintenance of Biodiversity and ecosystem services. The LIFE Methodology can be used both as an Environmental Management System (an organization's environmental plan) and/or as a certification scheme. The multidimensional guidelines and main points of intervention offer different action plans:

*   an Environmental Management plan, thanks to LIFE policies and reference documents and the implementation of LIFE management indicators;

*   an Impacts analysis through the calculation of LIFE Impact Index on Natural Capital, performance of an impact assessment on biodiversity and ecosystem services:

*   the prospect of conservation actions following a scoring of all conservation actions already implemented and/ or development of an action plan focused on biodiversity and ecosystem services.

Calculations are automatically performed by LIFE Software (LIFE Key) once the requested data are provided, coupled with the use of LIFE Matrix of Impacts on Biodiversity and Ecosystem Services resulting from the company's operations. Data is obtained from official documents and bodies/agencies (or internationally recognized organizations). This module helps the identification/analysis of business impacts as well as the dependencies, risks and opportunities related to them. Calculations are based on selected environmental aspects that can be measured (or estimated) by any type of company: waste generation, GHG emission, water consumption, energy use and the area occupied by the operations. The impact of each one of these aspects is calculated in terms of quantity and severity.

Important advantages of such tool include the use of external scientific sound studies and the inclusion of variables relevant to B-INTACT to provide an impact assessment, such as land conversion, pollution, climate change and large environmental disturbances. Although training is recommended prior to the use of the software, it is user-friendly and can be used by non-experts, an important aspect for the sake of accessibility to a broad audience supported by EX-ACT and B-INTACT.

However, the use of the LIFE Index also requires to rely on national data provided by officials and this is a time consuming and costly process. Although the use of primary data would contribute to a highly accurate and precise assessment, this last aspect could be an important barrier to the smooth functioning of B-INTACT if it were to rely on the LIFE Index.

The **Product Biodiversity Footprint** (PBF), developed by I-CARE and Consult and Sayari, focuses on the environmental impact assessment of a given product. It relies on a Life Cycle Assessment framework, and covers 5 pressures put on biodiversity: land use change, pollutions, climate change, invasive species and overexploitation of species. The PBF is declined in three modules:

- The first one conducts an overall value-chain analysis, relying on LCA methodologies, and results in a better understand of sources of ecological footprint, both spatialized and along the value chain.

- The second module focuses on a quantitative assessment of practices and spatial location, and allows users to compare between different scenarios.

- The third module offers a qualitative assessment of issues lacking in the LCA model on invasive species and species management, looking at overexploitation and sustainable management practices issues as well.

The PBF assessment methods covers the major issues regarding biodiversity assessment and provides a thorough understanding of a product ecological footprint. As the targeted audience is mostly orientated towards businesses and the model relies on a Life Cycle Assessment method, B-INTACT could not make use of it. Indeed, the Biodiversity Integrated Assessment and Computation Tool seeks to offer a state appraisal of biodiversity impact generated by an AFOLU project and would go further into local specificities and impacts than the second module from PBF.

The **Living Planet Index**, developed by World Wide Fund for Nature (WWF) and Zoological School of London (ZSL), uses MSA to measure and inform on the state of global biodiversity. The index relies on a rich database constituted of time-series of over 20 000 populations scattered around the world and results in a measurement of trends in different domains. Average changes in trends among species are calculated at the species levels, and then aggregated to result in a global assessment of the biodiversity state. The calculations include a weighting system that can be adjusted for species, realms and groups. This database is not field based, but collected from other sources like science articles, online data and national reports.

This index relies on a broad database, providing for a comprehensive and extensive assessment of the biodiversity state. Important barriers for the use of the LPI in B-INTACT is the lack of pressure impact assessment. Land-use is one of the main concerns of B-INTACT, which is not reflected through the LPI, thus limiting the possibilities to include such index in the updated version of the tool.

The **Species Threat Abatement and Recovery (STAR) metric**, previously known as Biodiversity Return on Investment Metric (BRIM), was developed by the International Union for Conservation of Nature (IUCN). The model focuses on the positive impacts on biodiversity from financial assessments. With this method of assessment, financial institutions can achieve conservation outcomes by assessing their biodiversity impact on the site-level. The main goal of the model is to calculate the reduction of extinction risks from endangered species, relying on the IUCN Red List database. STAR allows a comparison between ex-ante and ex-post results of investment implementation, with space and time embedded data.

Although the metric focuses on endangered species and risks bone by them, it does not consider other pressures on biodiversity generated by the AFOLU sector.

The **Biodiversity Footprint** model, developed by Plansup, can be used to assess both current and estimated future biodiversity footprint of a company's impact at the landscape level. With the tool, companies can assess their biodiversity impact of selected pressures from parts of the supply chain. Moreover, the tool allows a company to test the effectiveness of presumed biodiversity-friendly measures. Plansup has developed two models around the Biodiversity Footprint methodology:

1. The Biodiversity Footprint Method (BFM) calculates the impact of the three most important terrestrial pressure types: land use, GHG emissions and water use, as well as the impact of one

of the most important aquatic pressure types, namely emission of nitrogen and phosphorus in (inland) water. The impact is calculated for all parts of the product chain.

2. The Biodiversity Calculator is a free calculation tool to assess both current and future biodiversity footprint of a company's product at the landscape level. With the help of this tool, companies have an opportunity to calculate their biodiversity footprint online and assess the range of their biodiversity-friendly measures. It is based on the GLOBIO methodology and therefore it gives only an indication of the generic impact on biodiversity. It calculates the biodiversity impact of a company's supply chain, production process and transport that can be related to one or more products, giving the opportunity to input different scenarios.

This tool would allow for a comparative analysis between a baseline scenario and a scenario "with project" as in the current Biodiversity Integrated Assessment and Computation Tool, thus assessing potential future measures taken by the entity towards a biodiversity-friendly plan of action. It also allows users to input weight factors, generating a more specialized analysis of a local-specific project. However, the tool is more suited for supply chain analyses of a single commodities, rather than assessing the detailed impact of different types of AFOLU activities, and it does not allow the separate assessment of a land use component.

The **Biodiversity Footprint Approach**, developed by the Algemene Spaarbank voor Nederland (ASN) Bank, takes the natural biodiversity as a reference point to assess a biodiversity impact expressed in terms of an increase or a decrease in number of species present on site. This approach uses the PDF metric, and is time and space specific. The Biodiversity Footprint approach is based on the ReCiPe biodiversity impact model, which calculates the impact of environmental pressures on human health, resource scarcity and biodiversity. It makes use of the Exiobase datasets, which gathers data relevant to the expenditure by governments, which in turn helps to conduct a footprint analysis on its portfolio level. The approach also takes into consideration the climate change pressure impact on biodiversity, expressed in PDF. A qualitative analysis is also included, and covers the following pressures: land conversion, pollution, climate change, overexploitation, introduction of invasive species and disturbance. The results of the qualitative analysis highlight "risk factors" that further unveils sectors of biodiversity loss that are not accounted for through the ReCiPe method.

Despite the many variables included in this approach to biodiversity impact assessment, it disregards issues that seem relevant to B-INTACT, such as water scarcity, presence of endangered species, introduction of endangered species, overexploitation of resources, among others. This approach also differs from the intentions of B-INTACT as it expresses the results in PDF metric rather than MSA.

Bioversity International has developed the **Agrobiodiversity Index** with the goal of identifying challenges and barriers to the achievement of sustainable food systems. The index covers three domains: diets and markets, production systems and genetic resources. The Agrobiodiversity index measures different variables that will result in informative score for users. The three measures are as follows:

- The current state of agrobiodiversity, by analyzing different indicators, such as diversity of crop, crop wild relatives, fish, livestock and pollinator at 5 different levels.
- The commitments made in public strategies from policies, declarations, guidelines from different entities from both the private and public sector.
- The actions taken by monitoring policies, investment and practices at different governance levels.

Although this index covers important aspects of agrobiodiversity, the focus sought by B-INTACT is to assess the biodiversity impact generated by a project of the AFOLU sector. Despite the presence of the state of agrobiodiversity in the Agrobiodiversity Index, commitments made through public strategies and monitoring different allegiances from different governance levels are of little relevance to the biodiversity assessment in B-INTACT. The latter seeks to frame direct pressures on biodiversity enhanced or reduced by the implementation of a project, but cannot account for public and private strategies.

A.1.3   Additional biodiversity pressures in the GLOBIO model

Impact of nitrogen deposition

The adverse effects of atmosphere nitrogen deposition on biodiversity become significant only after levels surpass the assimilative capacity of the ecosystem, namely the critical load (Bouwman *et al.,* 2002, Stephfest *et al.,* 2014). The GLOBIO model calculates MSA_N based on the deposition in excess of the critical load (N exceedance; N_E):

$$N_E = N_D - N_{CL}$$

(Eq. 7)

Where N_E is the nitrogen deposition in exceedance of the critical load (all expressed in $g/m^2/yr$), N_D is the nitrogen deposition, and N_{CL} is the nitrogen critical load.

As field-level data on nitrogen deposition would be difficult to obtain, the tool developers have excluded this pressure impact from B-INTACT. An assessment of the biodiversity impact from pollution is hence covered in the qualitative approach.

Impact of climate change

The GLOBIO model, which covers a global-level scale, also takes into account the impact of climate change. However, the impact of greenhouse gas emissions on climate change is not limited to a restricted (project) area, nor to a specific project period (see **Box 1**). As B-INTACT addresses project-level appraisals, the FAO experts and a panel of biodiversity experts agreed to exclude this from the impact appraisal.

> **Box 1. Challenges in linking greenhouse gas emissions and climate change**
>
> Climate change is the consequence of GHG emissions since the beginning of the industrial era. The lifespan of GHGs in the atmosphere varies from around 10 years for methane to several thousand years for certain halocarbons. Therefore, present climate change is the result of current and past emissions as well, causing an inertia effect of past emissions. Calculating the individual contribution of a given GHG emission to biodiversity loss due to climate change is thus a complicated task. Strictly speaking, the contribution of an emission should be included not only for the year in progress but for its entire lifespan in the atmosphere. This raises a uniformity issue since only the annual impacts are considered for the other drivers. Assuming that present and future losses can be aggregated, the question then becomes: Which impact time period should be considered? Factoring in the entire lifespan of a GHG emission is not an option since it requires to forecast biodiversity trends over timeframes spanning way beyond temporal limits of the models. Picking an end date and focusing on the biodiversity loss through that date implies a mechanically decreasing impact of emissions since those emitted in the first years stay longer in the atmosphere. The solution of a rolling window over a fixed period – say the next 20 years – is neither satisfactory as the size of the window impacts widely the results. Lastly, global warming is the consequence of a series of aggregated emissions above the Earth's absorption capabilities. In this context, focusing on individual emissions seems irrelevant. This brings us back to the issue of the legacy of past emissions. Consequently, the quest for a "scientifically accurate" solution to calculating the contribution of a given GHG emission to annual biodiversity loss has been abandoned.
>
> Source: CDC Biodiversité, 2017.

EX-ANTE CARBON-BALANCE TOOL [EX-ACT]

The EX-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The tool helps project designers estimate and prioritize project activities with high benefits in terms of economic and climate change mitigation, and it helps decision-makers to decide on the right course to mitigate climate change in agriculture and forestry and to enhance environmental services.

WEBSITE | www.fao.org/in-action/epic/ex-act-tool