ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

RESEARCH 2021-2022

Assessment of Projects for (a) integrated climate-biodiversity action and (b) attractiveness to investments

Final Report

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Table of Contents

INTRODUCTION

This report presents the research on assessing infrastructure projects for their integrated climate biodiversity performance and the financial attractiveness of such projects. The research is a continuation of the "Assessment of Projects for (a) mitigation and adaptation to climate change and (b) attractiveness to investments" project - presented in a draft final report[1] on June 15, 2021. The report assesses how Envision® captures climate change-related risks and opportunities as identified in the literature and assist to its alignment to current trends of urgent response to the climate crisis.

The need to capture (a) the risk of climate change on biodiversity and (b) biodiversity's role in climate action were identified as additional research areas in the completed research. Moreover, climate change mitigation and adaptation[2] actions can unintentionally impact biodiversity long term. Therefore, the proposed work continues in climate change-related risks and opportunities, expanding the boundary of research to encompass biodiversity & climate change-related risks and opportunities.

Moreover, the work is motivated by emerging evidence of a biodiversity crisis in parallel with the climate crisis and the related ongoing discourse on the climate-biodiversity nexus and the need for integrated solutions to deal with both threats simultaneously. Awareness of biodiversity loss as a threat to humans and their activities is gaining momentum internationally, also reflected in ESG reporting practice.

[1] Pollalis, S.N., E. Chatzistavrou, A. Kouveli, E. Marinou, J. Rodriguez, and O. Tzioti, (June 2021). "Assessment of projects for (a) climate change mitigation and adaptation and (b) attractiveness to investments," Research report, Zofnass Program for Sustainable Infrastructure and accompanying presentation.

[2] Climate change mitigation is defined as a human intervention to reduce emissions or enhance the sinks of GHG emissions. (IPCC, 2014)
Climate change adaptation is the process of adjustment to actual or expected climate and its effects in human systems. (IPCC, 2014)

The 'twin' biodiversity and climate crises redefine what the 'right projects,' a priority of Envision, should be, moving from a climate-focused to an integrated climate-biodiversity solution. Therefore, **the updated research title is: 'Assessment of Projects for (a) integrated climate-biodiversity action and (b) attractiveness to investments'**

1. SCOPE OF RESEARCH

The 2020-21 ZHP research aimed to assist the Envision framework in adapting and contributing to the ongoing global discourse and research on climate change and the urgency of channeling investments in climate action projects.

Key related research areas were highlighted, and current climate-action goals were identified based on a literature review (a) on climate change and (b) the investors' demand for climate action. The analysis of selected established ESG standards – the primary tool for investor knowledge on companies' sustainable performance- and climate-related reporting frameworks like the Taskforce for Climate-related Financial Disclosures (TCFD) recommendations provides additional insight on how climate-related performance is defined and communicated to investors.

Based on the findings of the literature review and the ESG systems analysis, **key criteria for assessing climate-related performance were identified and used for a targeted analysis of Envision.** The analysis focused on (a) how Envision assesses project performance in climate change mitigation and adaptation, (b) if Envision is in line with current trends and methods and (c) if the climate-related risks and opportunities of projects for investors are adequately captured.

The findings of the review process were synthesized in:

- identified gaps in Envision's climate-related assessment of projects and guidance to project teams,
- potential recommendations to Envision on how to address the identified gaps and enhance its climate-related assessment and guidance, and
- prioritized Envision credits to assist in selecting the right projects for climate action, which is critical in the current climate emergency.

However, the research so far and the key criteria used as part of the analysis methodology are yet to be evaluated if appropriate for a complete review of the Natural World credits of Envision in terms of climate change mitigation and adaptation, as well as the potential of Nature-based Solutions for climate action and relevance to investors. As already explained within the Research 2020- 2021 report:

In general, by referring to habitat and biodiversity protection and enhancement, the Natural World credits contribute to the preservation and enhancement of 'natural capital' with value both for the infrastructure owner, the manager, and the community. The landscape has the singularity of being both a solution to climate change (natural carbon sink) and recipient of direct pressure by its impacts. […] Due to the topic's extent and complexity, the research did not focus on nature-based solutions for climate change mitigation and adaptation.

Moreover, in parallel to the climate crisis, the urgency to halt and reverse biodiversity loss is gaining global momentum. Emerging evidence points out unprecedented and accelerating biodiversity loss on a worldwide scale. Awareness of biodiversity loss as a threat to humans and their activities, as well as to achieving urgent climate goals set, has resulted in initiatives for setting nature-related targets:

- Become nature-positive by 2030 to halt and reverse nature loss and support the SDGs.[3]
- 'Living in harmony with nature' by 2050.[4]
- Protect or conserve at least 30% of the planet by 2030.

This global agenda is also reflected in changes to the ESG landscape with an increased focus on biodiversity. Further evidence of this trend is the recent formation of TNFD, the Taskforce on Nature-related Financial Disclosures, with the mission to develop recommendations on how biodiversity is comprehensively accounted for in future investment decisions and engagements (similarly to the work of the TCFD for climate). The TNFD Recommendations are due to be published by 2023.

Therefore, the key role of biodiversity in climate action and the need for integrated solutions for both the climate and biodiversity crises expand the scope of the research to encompass biodiversity-related risks and opportunities of climate change and climate action, to eventually capture the climate-biodiversity nexus risks and opportunities.

The expanded research scope aims to assist the Envision framework in identifying and prioritizing projects that demonstrate the most robust win-win solutions for climate change action and biodiversity.

2. RESEARCH METHODOLOGY

The methodology proposed for the 2021-22 Research is similar to the one developed for the 2020-21 Research, following five key parts:

- Literature review.
- ESG reporting systems analysis.
- Identification of key criteria for biodiversity action.
- Review of Envision framework based on criteria outcome of Literature review and systems analysis.
- Use of case studies.

Each of these parts will have its detailed methodology briefly described in this document and will be further detailed and refined based on the ongoing work findings.

[3] https://www.naturepositive.org/

[4] Target of the post-2020 global biodiversity framework which builds on the Strategic Plan for Biodiversity 2011-2020 and sets out an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity, ensuring that by 2050 the shared vision of 'living in harmony with nature' is fulfilled.

The overall proposed methodology for the research on the climate-biodiversity nexus consists of:

A. LITERATURE REVIEW

A1. Literature Review on the biodiversity crisis and the biodiversity-climate nexus:

- Biodiversity loss as one of the top global threats, and current action for halting and reversing it
- Biodiversity's contribution to climate change action/ biodiversity as part of climate pathways and its critical role for achieving Paris Agreement targets
- Biodiversity's contributions to people and business dependencies
- Relation between biodiversity and climate change
- The process of carbon sequestration by ecosystems. An overview of the links between the carbon cycle and climate. Which are the main components of the carbon cycle? It is essential to understand both the impact of climate change on natural processes and the contribution of nature to climate change mitigation.
- The natural carbon sequestration potential and quality of carbon stock, dependent on (1) ecosystem type and (2) ecosystem condition
- Impact of climate change on biodiversity (impacts per main ecosystem types identified terrestrial, freshwater, and marine ecosystems)
- Unintended impact/ risk of climate change mitigation actions on biodiversity (impacts per type of solution: technical/ technological, NbS, combined Technical-NbS). Addressing climate change issues may become counterproductive if actions initiated to reduce greenhouse gas emissions aggravate biodiversity decline.
- Need for an integrated approach to climate change and biodiversity loss
- The relation between nature-positive and carbon-neutral targets by 2030
- Biodiversity and SDGs
- Nature-based Solutions (NbS). Which actions are encompassed under the NbS definition?

It is worth highlighting that the IPBES-IPCC report, which serves as a central and recurrent reference for the current research, uses the concept of ecosystem services, or 'nature's contributions to people'- the alternative term IPBES uses to refer to ecosystem services- to demonstrate the impact of climate change to biodiversity, as well as the role of biodiversity as an integral part of climate action. Ecosystem services are evidence of the Nature-based Solutions' potential for multiple benefits. A growing body of literature supports that assessment of the performance of NbS should be ecosystem services-based. Therefore, an additional literature review is required on:

- The ecosystem services concept
- The links between biodiversity and ecosystem services
- Ecosystem services-based assessment and accounting approaches and their theoretical frameworks. Both cases are helpful for the research, given that they both aim to inform decision-making and make explicit the benefits that ecosystems provide.

A2. Literature Review on biodiversity as part of investors' agenda (through ESG reporting):

- The emergence of biodiversity as the next priority for investors

- Criticism that the 'E' of ESG has become nearly synonymous with attempts to mitigate climate change.[5]
- Biodiversity accounting in existing ESG systems
- New initiatives and updates of existing ESG systems to better account for biodiversity and ensure that the biodiversity-related risks and opportunities gain visibility among investors and companies.

B. ESG SYSTEMS ANALYSIS

Analysis and cross-examination of selected established ESG reporting frameworks and standards to identify the current approach to biodiversity-related reporting. This analysis allows identifying biodiversity-related data relevant to investors and suggests that companies communicate to investors to guide decisions. Specific focus is given on analyzing the Taskforce for Nature-related Financial Disclosures (TNFD) in-progress work that aims to mainstream biodiversity loss as a financial risk by connecting it to potential financial impacts for companies.

- The TNFD (Taskforce on Nature-related Financial Disclosures) with the mission to develop recommendations on biodiversity-related accounting into investment decisions and engagements (similarly to the work of the TCFD for climate). Given that the TNFD Recommendations will be published by 2023, the analysis will be based on available resources.
- The CDSB ESG framework's draft guidance for Biodiversity-related disclosures, currently in the process of public consultation, and
- The GRI Standards review of their Biodiversity standard (of 2016) as a priority in their work plan for 2020-22.

In parallel to the ESG systems analysis and since Envision is an infrastructure project performance assessment tool, the ecosystem assessment and accounting systems analysis is also suggested to address the question 'how biodiversity-related performance is being assessed?' The analysis will focus on the theoretical frameworks that underlie these approaches and their ecosystem services classification systems. Seven approaches to the classification of ecosystem services will be analyzed to finally select one system to be used for a detailed analysis of ecosystem services and their relevance and importance to climate change mitigation and adaptation:

- the Millennium Ecosystem Assessment6 (MA) framework (2003, 2005);
- the De Groot et al. (2002);
- the US Environmental Protection Agency (EPA) 's National Ecosystem Services Classification System (NESCS) (2015, 2020);
- the European Environmental Agency's Common International Classification of Ecosystem Services (CICES)[7] (2013, 2018)

[5] Financial Times. (July 2020). "ESG investors wake up to biodiversity risk."

[6] The Millennium Ecosystem Assessment (MA) was called for by the United Nations Secretary-General Kofi Annan in 2000. Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being, launched by the UN. (source: https://www.millenniumassessment.org/en/About.html)

[7] CICES has been used by the EU for the Mapping and Assessment of Ecosystem Services (MAES)

- the United Nations' System of Environmental-Economic Accounting (SEEA-EA) (2014, 2021);
- the United Nations Environment Program (UNEP) 's 'The Economics of Ecosystems & Biodiversity' (TEEB) (2013); and
- The IPBES Nature's Contribution to People (NCPs) framework (2017)

It is worth highlighting that the SEEA EA ecosystem accounting system refers explicitly to climate change highlighting that "ecosystem accounting can provide data to understand the key role ecosystems play in GHG cycling on global, national, and regional scales that underpin the carbon concentration in the atmosphere. In addition, data from ecosystem accounts can help understand the impact that climate change is having on ecosystems and biodiversity."[8]

Both ecosystem accounting and ecosystem assessment are frameworks for recording a range of climate change effects on the environment, on the extent (size) and condition of ecosystem assets and flows of ecosystem services.

A focus will be given on those ecosystem services that are more sensitive to climate change and those that hold mitigation and adaptation potential. However, a broader overview of all ecosystem services is also necessary to ensure that all potential trade-offs are accounted for as part of the assessment.

C. IDENTIFICATION OF KEY CRITERIA FOR ASSESSING BIODIVERSITY-RELATED PROJECT PERFORMANCE

Based on the literature review findings and the systems analysis, key criteria for assessing a project's performance against biodiversity-related risks and opportunities will be identified. In combination with the identified key criteria for climate change, these criteria will represent key criteria for integrated climate-biodiversity action.

D. ENVISION FRAMEWORK REVIEW

D1. Targeted review of Envision to explore if the climate change-related risks for biodiversity and biodiversity as an opportunity for climate change action are captured in the Envision Framework.

- Analysis of Envision to ensure risks for biodiversity are addressed through the Natural World category
- Review of Envision if its climate change-related risk assessment and risk management requirements capture the risk of the impact of climate change and climate action on biodiversity
- Envision's analysis ensures that the singularity of Nature-based Solutions, **nature-based climate solutions[9] in specific,** is adequately captured. NbS are widely recognized as crucial to responding to climate change and sustainable development challenges (SDGs) at the needed

[8] UN Department of Economic and Social Affairs Statistical Division, SEEA. (February 2021). System of Environmental-Economic Accounting—Ecosystem Accounting. Final Draft. Version 5.

[9] When NbS are intentionally used to respond to climate change they may be referred to as 'nature-bsed climate solutions' or 'natural climate solutions'. (source: De Lamo, X. et al. (2020) Strengthening synergies: how action to achieve post-2020 global biodiversity conservation targets can contribute to mitigating climate change. UNEP-WCMC, Cambridge, UK.)

scale and pace. NbS are recognized for their potential to contribute to climate change mitigation and adaptation while contributing to biodiversity conservation and human well-being.[10]

- Identification of gaps and recommendations to be considered as part of the next Envision update:
  - Should criteria be more aggressive given the current biodiversity crisis?

D2. Review based on current priorities for tackling biodiversity and climate twin crises together as they are identified in the literature:

- The top priority is the conservation of natural ecosystems, and, more important, carbon-rich ecosystems (IPBES-IPCC report, 2021). Relevance of Envision's Mitigation hierarchy.

D3. Review of Envision based on the assessment of ecosystem services and climate-relevant ecosystem services in particular. Envision will be cross-examined against a selected established Ecosystem Services classification system. "A classification can operate as a checklist" [11] ***therefore allows identifying:***

- Which ecosystem services are captured by Envision?
- Which credits implicitly refer to ecosystem services? etc.
- Which credits refer to conservation, restoration, or enhancement of ecosystems and by extension of ecosystem services?
- Moreover, if the performance assessment (particularly of NbS) could be enhanced based on input from assessing existing ecosystem services, etc.

It is worth mentioning that Envision cannot replace an ecosystem assessment framework. However, reviewing ecosystem assessment frameworks can provide feedback for an Envision-review that aims to capture the complex interactions of climate change-biodiversity.

E. USE OF CASE STUDIES

The analysis and review of specific projects as case studies, already part of the 2020-21 research, will be continued and enhanced with additional representative infrastructure project cases. The two case studies,[12] part of the 2020-21 research on climate change, will be updated with input from the proposed research on climate-biodiversity nexus. Additional infrastructure projects will be studied based on climate change and biodiversity-related actions.

Selected project examples are used to apply the outcomes of the literature review and the performed analysis and test if they adequately capture climate change and biodiversity-related project actions.

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[10] Naumann, S. and Davis M. (April 2020). "Biodiversity and Nature-based Solutions: Analysis of EU-funded projects." Independent Expert Report prepared for the European Commission.

[11] Lars Hein, with inputs from Ken Bagstad, Neville Crossman, Sander Jacobs, Alessandra La Notte, Carl Obst and UNSD. (September 2018). "SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Final Report.

[12] The two projects used as case studies are:
- The California High Speed Rail Program, an exemplary climate change mitigation project; and
- The Santa Monica Clean Beaches project, a multi-benefit project with contribution to climate change adaptation.

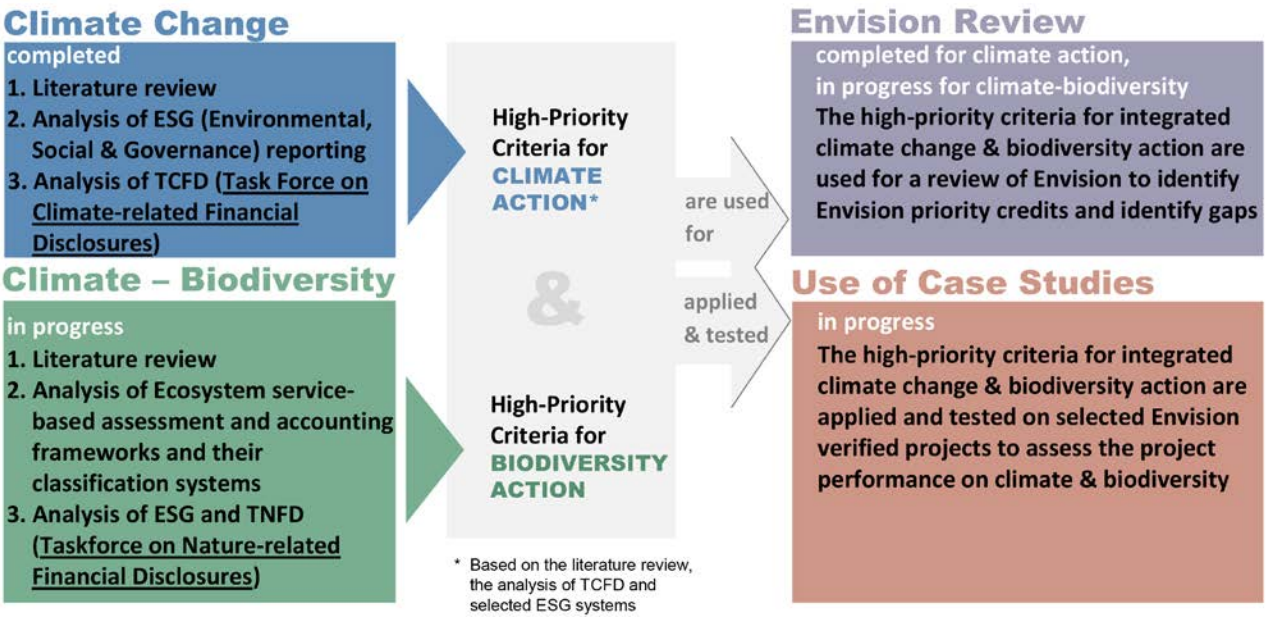

Fig. 1: Schematic representation of the overall research methodology

A detailed initial proposed methodology for case studies selection and analysis is presented in the Preliminary Progress on Research tasks document, part of the first submission for the 2021-22 Zofnass Program Research.

In brief, the proposed methodology consists of:

Project selection process

- Use of the ISI's Database of Envision awarded projects for identification of representative projects
- Two-step short-listing of projects based on specific selection criteria to ensure the selection of:
  (a) high-performance projects in terms of climate change and biodiversity action
  (b) different infrastructure types of projects for providing sector-specific risks and opportunities
  (c) different types of solutions:
    - Technical/ technological solutions,
    - Combined technical/ technological- Nature-Based Solutions,[13] and
    - Nature-based Solutions (NbS).

Request for Information

- Development of generic documents for Request for Information on the selected projects by their respective project teams
- Organization of discussions for targeted requests of information

Project analysis

[13] NbS can be implemented alone or in an integrated manner with other solutions (e.g. technological, engineering solutions).

The analysis of selected projects for integrated climate-biodiversity performance will be performed in two main phases:

- Analysis of climate change mitigation & adaptation performance
  - Identification of project strategies relevant to climate change mitigation and adaptation
  - Connection of strategies with the key criteria for assessment of climate change-related performance (outcome of the 2020-21 Research on Climate change)
- Analysis of biodiversity-related performance
  - Identification of Nature-based climate solutions among the project strategies
  - Connection of project strategies with key criteria for assessment of biodiversity-related performance (expected outcome of the 2021-22 Research on climate- biodiversity nexus)

PART 1: LITERATURE REVIEW

1. LITERATURE REVIEW ON BIODIVERSITY-CLIMATE

1.1. URGENCY FOR BIODIVERSITY ACTION

The Convention on Biological Diversity[14] (CBD) defines biodiversity as "the variability among living organisms from all sources including, among other things, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; it includes diversity within species, between species, and between ecosystems. Biodiversity thus includes the different species on earth. It also consists of the specific genetic variations and traits within species and the various types of diverse ecosystems, marine and terrestrial, such as coastal areas, forests, wetlands, grasslands, mountains, and deserts.[15]

Biodiversity (a term that is a contraction of 'biological diversity') is a remarkably complex concept. It comprises the three fundamentally different levels of genetic diversity, species diversity, and ecosystem diversity. Most of the policy and public debate on biodiversity protects specific species and habitats. Species diversity comprises concepts such as diversity, richness, abundance, and specific species (endemic, rare, red list).[16]

A 'change in biodiversity' could involve extinction, shift in range, change in abundance, or loss of genetic diversity.[17] The Essential variables for 'mapping and monitoring changes in biodiversity' are shown in Table 1.

[14] The CBD is the international Convention for biodiversity, equivalent to the UN Framework Convention on Climate Change.

[15] Secretariat of the Convention on Biological Diversity (CBD). (April 2018). "Biodiversity at the Heart of Sustainable Development." Input to the 2018 High-level Political Forum on Sustainable Development (HLPF).

[16] Lars Hein, with inputs from Ken Bagstad, Neville Crossman, Sander Jacobs, Alessandra La Notte, Carl Obst and UNSD. (September 2018). SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA. Final Report

[17] UNEP, CBD Subsidiary Body on Scientific, Technical and Technological Advice. (October 2013). "Essential biodiversity variables."

Table 1: The Essential Biodiversity Variables (EBVs).

EBV class	Essential Biodiversity Variable
Genetic composition	Allelic diversity
	Co-ancestry
	Population genetic differentiation
	Breed and variety diversity
Species populations	Species distribution
	Population abundance
	Population structure by age/size class
Species traits	Phenology
	Body mass
	Natal dispersal distance
	Migratory behaviour
	Demographic traits
	Physiological traits
Community composition	Taxonomic diversity
	Species interactions
Ecosystem structure	Habitat structure
	Ecosystem extent and fragmentation
	Ecosystem composition by functional type
Ecosystem function	Net primary productivity
	Secondary productivity
	Nutrient retention
	Disturbance regime

22 EBVs fall into six categories covering composition, structure, and function of both species (genetic composition, species populations, species traits), and ecosystems (community composition, ecosystem structure, ecosystem function)

In 2013, CDB established the above Essential Biodiversity Variables (EBVs) to manage the complexity when considering nature as a global system for harmonized observations, reporting, and managing biodiversity change.[18] The EBVs represent a set of fundamental observations needed to support multi-purpose, long-term biodiversity information needs at various scales.[19] CBD provides a set of indicators derived from the EBVs to facilitate the national implementation of global biodiversity targets and assess progress towards those targets.[20] The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), the body that performs global, regional assessments of the state and trends of nature structures its assessment upon the EBVs.

[18] In 2010, on request of the CBD, the Group on Earth Observations Biodiversity Observation Network (GEO BON) prepared an assessment of the adequacy of observation systems to provide the data needed for the Aichi targets. GEO BON guides the design and implementation of national, regional and thematic Biodiversity Observation Networks (BONs) worldwide. (source: UNEP, CBD Subsidiary Body on Scientific, Technical and Technological Advice. (October 2013). "Essential biodiversity variables.")

[19] UNEP, CBD Subsidiary Body on Scientific, Technical and Technological Advice. (October 2013). "Essential biodiversity variables."

[20] As in the case of the Aichi Biodiversity targets and the proposed global indicator framework. Secretariat of the Convention on Biological diversity. (July 2016). "Generic and specific indicators for assessing progress in the attainment of the AICHI biodiversity targets, including an assessment of their main characteristics."

1.1.1. Evidence that current levels of biodiversity loss is a threat

Direct drivers (pressures) of biodiversity decline include land/sea use intensity and change, direct exploitation of organisms, pollution, climate change, and invasive species (IPBES, 2019). Indirect drivers are the more distant causes of biodiversity decline. They are underpinned by societal values, including key institutional and governance structures in addition to social, economic, and cultural contexts that drive human behavioral patterns such as consumption and energy use. Climate change and biodiversity decline share the same indirect drivers, which are the ultimate forces that underlie and shape the extent, severity, and combination of direct anthropogenic drivers that operate in each place.[21]

The urgency to halt and reverse biodiversity loss is gaining global momentum due to emerging evidence pointing out unprecedented and accelerating biodiversity loss on a worldwide scale.

Evidence of biodiversity loss:

- The rate of species extinctions of plants, mammals, fish, and others is approximately 1,000 times higher than background extinction rates, and the total numbers of wild mammals (measured in biomass) declining by 82% compared to historical records, being described by scientists as a 'biological annihilation.'[22]
- An average of 25% of species in the assessed animal and plant groups are threatened, suggesting that around 1 million species already face extinction.
- 75% of the land surface is significantly altered, 66 % of the ocean area is experiencing increasing cumulative impacts, and over 85 % of wetlands (area) have been lost.[23]
- The world's natural ecosystems decline in extent (size) and condition by 47% compared to estimated baselines.[24]
- Biodiversity loss has been ranked as the second most impactful and third most likely risk for the next decade.[25]
- Biotic integrity - the average abundance of native species (naturally present species)- in most major terrestrial communities has fallen by 23% compared to historical records, potentially affecting ecosystem processes and hence nature's contributions to people.[26]
- Today only 15% of land and 7% of the ocean are protected.[27]

[21] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

[22] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.

[23] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

[24] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[25] World Economic Forum publishes the 15th edition of the *Global Risks Report.*

[26] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

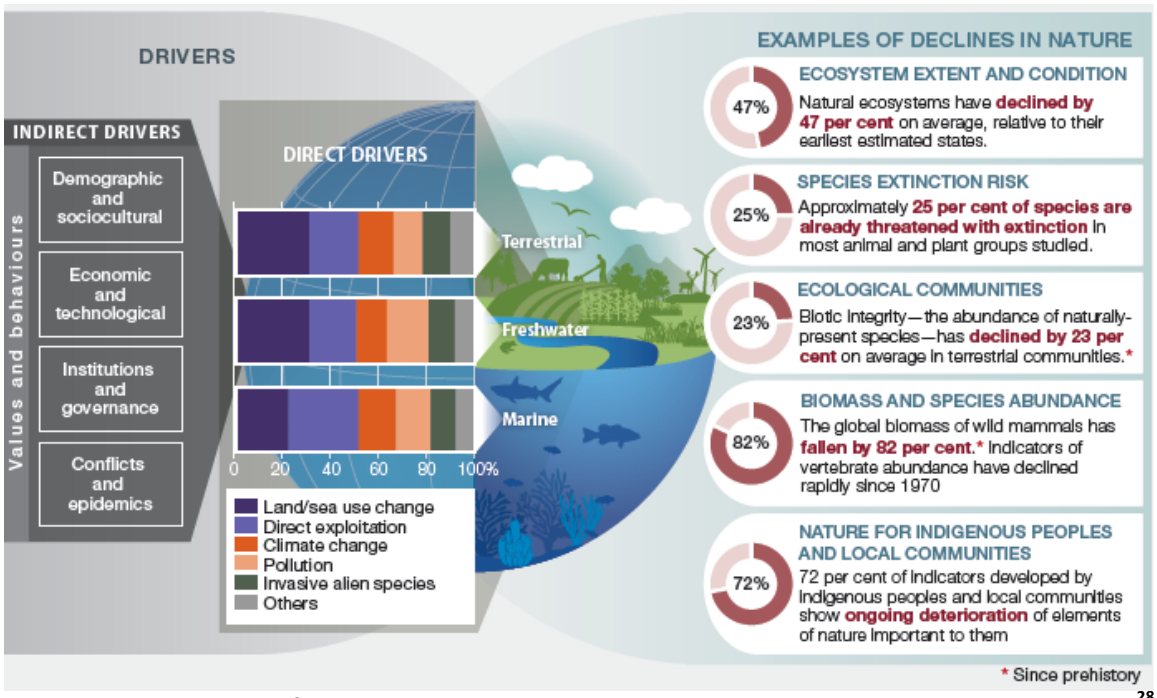

Fig. 2: Summary of declines in nature as assessed by the IPBES 2019 Global Assessment Report[28]

What is alarming is that evidence indicates that global biodiversity decline occurs at rates higher than ever before. Moreover, the biodiversity status and trends have extensive social implications, and the risk exists that biodiversity loss undermines the climate change mitigation goals. If current land conversion rates and other threats are not markedly slowed or halted in the next ten years, "points of no return" will be reached for multiple ecosystems and species."[29]

At present, about 60% of the CO_2 emitted into the atmosphere by fossil fuels each year is sequestered by nature's carbon sink in the land and the oceans, providing a vital role in regulating the earth's climate. However, "climate models show that we are approaching a tipping point: if current trends in habitat conversion and emissions do not peak by 2030, then it will become impossible to remain below 1.5°C of pre-industrial levels."[30]

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27 30x30 campaign for nature- protect or conserve at least 30% of the planet by 2030, https://www.campaignfornature.org/

28 IPBES. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

29 Sala et al. (April 2019) A Global Deal For Nature: Guiding principles, milestones, and targets

30 Sala et al. (April 2019) A Global Deal for Nature: Guiding principles, milestones, and targets

1.1.2. Key Milestones for Biodiversity

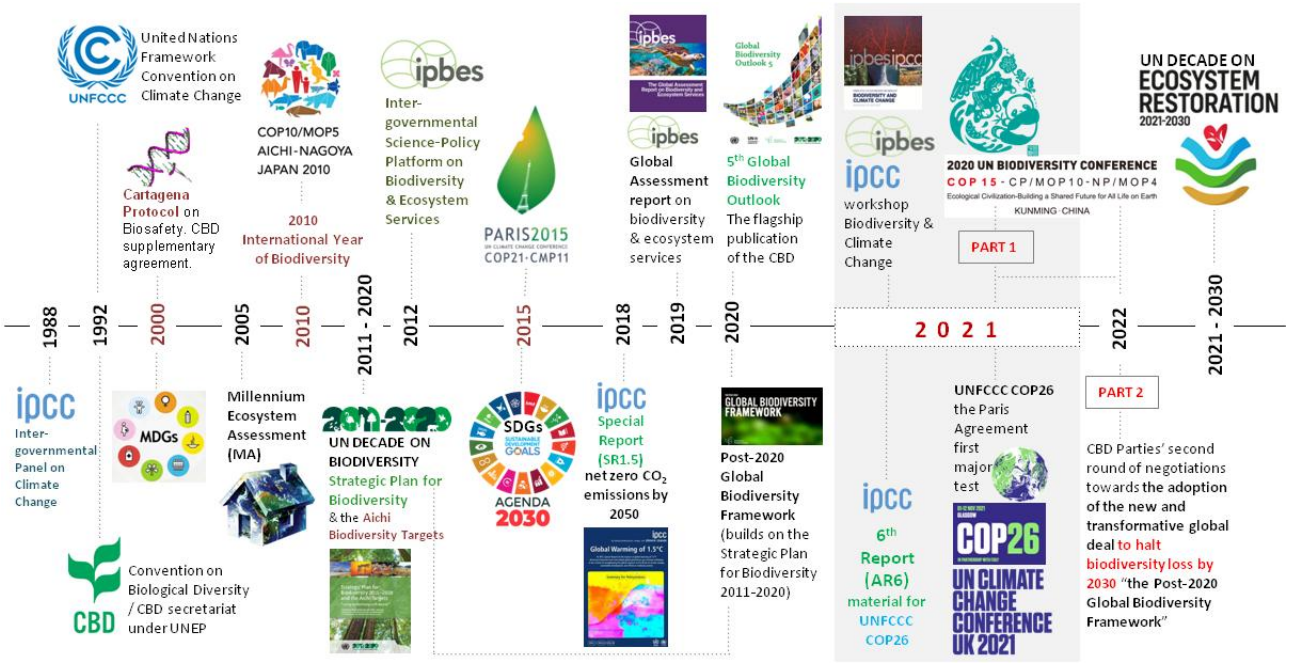

Fig.3: Timeline of key milestones for biodiversity: establishment of international institutions, conventions, and publication of reports

Biodiversity, being recognized as a pressing issue at a global scale and "a common concern of humankind," as well as an integral part of the development process, has its international Convention, the Convention on Biological Diversity (CBD), and its intergovernmental body, which assesses available knowledge, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), similarly to climate change and its UN Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) respectively.

The Convention on Biological Diversity (CBD), established in 1992 by the UN during the Earth Summit,[31] is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" that 196 nations have ratified.[32] The convention's governing body is the Conference of the Parties (COP), consisting of the governments that have ratified the treaty, which advances the implementation of the decisions in its biannual meetings. The Conference of the Parties has held 14 ordinary meetings and one extraordinary meeting.[33]

[31] The three Rio Conventions—on Biodiversity, Climate Change and Desertification—derive directly from the 1992 Earth Summit, held by the UN. Each instrument represents a way of contributing to the sustainable development goals of Agenda 21. The three conventions are intrinsically linked, operating in the same ecosystems and addressing interdependent issues.

[32] https://www.un.org/en/observances/biological-diversity-day/convention

[33] https://www.cbd.int/cop/

The Convention is legally binding and requires that countries prepare National Biodiversity Strategies and Action Plans (NBSAPs) and ensure that these strategies are integrated into activities in all sectors where biodiversity may be impacted. The NBSAPs are equivalent to the Nationally Determined Contributions (NDCs) and long-term strategies (LTS) required under the Paris Agreement on climate change.

The CBD develops the Global Biodiversity Outlooks, its flagship publication of periodic reports that summarize the latest data on the status and trends of biodiversity and draw conclusions relevant to the further implementation of the Convention. The CBD Global Outlook summary of progress towards biodiversity targets set is based on research studies, assessments by the IPBES, and the national reports of the member countries implementing the CBD.

The IPBES, established in 2012, is an independent intergovernmental body comprising over 130 member Governments. IPBES provides policymakers with objective scientific assessments about the state of knowledge regarding the planet's biodiversity, ecosystems, and their contributions to people, options, and actions to protect and sustainably use these vital natural assets.[34] IPBES develops global, regional, and thematic assessment reports.

2010 was a landmark year for biodiversity, also known as the 'international year for biodiversity.' It was first set during the COP6 in 2002 as a target year for halting biodiversity loss "as a contribution to poverty alleviation and the benefit of all life on Earth." The 2010 Biodiversity target was also incorporated as a new target under one of the Millennium Development Goals (MDGs) - Ensure Environmental Sustainability.[35]

Failure to reach at a global level the targets set by 2010 was documented in CBD's 3rd Global Biodiversity Outlook (2010). Following a recommendation of CBD signatories during COP 10 at Nagoya, Japan, the UN, in December 2010, declared 2011 to 2020 as the United Nations Decade on Biodiversity, recognizing the need to address the principal pressures leading to biodiversity loss that were not just constant but were, in some cases, intensifying. COP 10 adopted a revised and updated Strategic Plan for Biodiversity for the period 2011-2020, which included the 20 Aichi Biodiversity Targets around five Strategic Goals, setting benchmarks for improvements across drivers, pressures, the state of biodiversity, the benefits derived from it, and the implementation of relevant policies and enabling conditions.

The United Nations General Assembly has recognized the Strategic Plan for Biodiversity and its Aichi Biodiversity Targets as setting the global framework for priority actions on biodiversity.

[34] IPBES. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

[35] CBD. (2010) "Global Biodiversity Outlook 3: Introduction." https://www.cbd.int/gbo3/?pub=6667&section=6680

Fig. 4: Overview of Aichi Biodiversity Targets[36]

The 5th is the latest publication of the CBD, which spelled out the failure to the 20 Aichi Biodiversity targets, with none of them fully achieved, despite the progress made. The conclusions of the Outlook were based on the IPBES Global Assessment report on biodiversity and ecosystem services of 2019, developed after an invitation by the Conference of Parties (COP) of the CDB to contribute to the evaluation and renewal of the Strategic Plan for Biodiversity and its Aichi Biodiversity Targets. The overall scope of the report was to assess the status and trends regarding biodiversity and ecosystem services, the social implications of these trends, and to assess progress concerning the Strategic Plan and its Aichi Biodiversity targets as well as the SDGs and the Paris Agreement, and provide an agreed evidence-based knowledge base to inform policymaking for the decade 2020-2030. It is a critical assessment, the first global report in almost 15 years - after the Millennium Ecosystem Assessment (MA) in 2005, called for by the UN Secretary-General Kofi Annan in 2000, which was then related to the Millennium Development Goals."[37]

With the failure to achieve the Aichi targets for the period 2011-2020, a new focus has been put to the decade 2021-2030, with the launch of the 'UN Decade of Ecosystem Restoration from 2021 through 2030', which is also the deadline for the SDGs and the timeline scientists have identified as the last chance to prevent catastrophic climate change.

The kick-off of this decade is also marked with the 15th COP of the CBD (COP15) held in Kumming, China, in October 2021 and also planned in April 2022, where the post-2020 Global Biodiversity framework is to be negotiated, setting the next round of biodiversity targets. CBD's Draft Post-2020 Global Biodiversity Framework builds on the Strategic Plan for Biodiversity 2011-2020. It sets out an ambitious plan to

[36] https://www.cbd.int/sp/targets/

[37] IPBES. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

implement broad-based action to ensure that by 2050 the shared vision of 'living in harmony with nature' is fulfilled.[38]

The Draft Framework comprises 21 targets and 10 'milestones' proposed for 2030, en route to the 'living in harmony with nature' goal by 2050. Key action targets include:[39]

- Ensuring that at least 30% globally of land areas and sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative, and well-connected systems of protected areas and other effective area-based conservation measures and integrated into the broader landscapes and seascapes.
- Preventing or reducing the rate of introducing and establishing invasive alien species by 50% and controlling or eradicating such species to eliminate or minimize their impacts.
- Reducing nutrients lost to the environment by at least half, pesticides by two-thirds, and eliminating the plastic waste discharge.
- Use ecosystem-based approaches to mitigate and adapt to climate change, contributing at least 10 GtCO2e per year to mitigation, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity.
- Redirect, repurpose, reform, or eliminate incentives harmful for biodiversity in a just and equitable way, reducing them by at least $500 billion per year.
- Increase financial resources from all sources to at least US$ 200 billion per year, including new, additional, and adequate financial resources, increasing by at least US$ 10 billion per year international financial flows to developing countries, leveraging private finance, and increasing domestic resource mobilization, taking into account national biodiversity finance planning.

1.1.3. Demand for nature positive targets

"Scientists tell us that we only have a window of 10 years to solve the climate crisis and to reverse the severe trend of biodiversity loss."[40] "Without urgent action to halt and reverse biodiversity loss, reductions in greenhouse gas emissions to limit warming to close to 1.5°C or even 2°C will not be achieved."[41]

Awareness of biodiversity loss as a threat to humans and their activities, as well as to achieving urgent climate goals, has resulted in initiatives for setting nature-related targets:

[38] Convention on Biological Diversity (CBD). (July 2021). "First Draft of the Post-2020 Global Biodiversity Framework." https://www.cbd.int/article/draft-1-global-biodiversity-framework

[39] Convention on Biological Diversity (CBD). (July 2021). "First Draft of the Post-2020 Global Biodiversity Framework."

[40] UNEP WCMC. (November 13, 2020). Research reveals benefits of joint action on climate and nature. https://www.unep-wcmc.org/news/research-reveals-major-benefits-of-joint-action-on-climate-and-nature

[41] IPBES-IPCC Report, and also article Bridging COP26 and COP15: EU highlights the need to tackle the nature and climate crises together, 29 October 2021.https://ec.europa.eu/environment/news/bridging-cop26-and-cop15-2021-10-29_en

- Become nature-positive by 2030 to halt and reverse nature loss and support the SDGs.[42]
- 'Living in harmony with nature' by 2050.[43]
- The 30x30 campaign to protect or conserve at least 30% of the planet by 2030. If done in the right locations, protecting at least 30% of the planet is a nature-based solution with enormous biodiversity and climate benefits, including climate change resilience, adaptation, and mitigation.

The calls for action and time-bound global goals for nature, similarly to climate change global goals, have multiplied in the run-up to the 2021 CBD COP15 and the UNFCCC COP26 negotiations of 2021 as a form of pressure for reaching an agreement for nature action in both Conferences of Parties. They are based on the scientific evidence on the accelerated biodiversity decline that has emerged. A common feature is the target for no net loss after 2020 (year used as a baseline) and 30% protection of land and marine ecosystems by 2030, as an interim target to 2050. This target has been formally defined in the CBD's 1st draft Post-2020 Strategic Framework to be agreed upon as the new biodiversity target for the decade 2021-2030:

- The Global Deal for Nature initiated by political leaders targets 30% of the earth to be formally protected and 20% designated as climate stabilization areas by 2030 to remain below 1.5°C.
- The Global Apex for Nature initiated by WWF and supported by organizations such as the World Resource Institute (WRI), the World Business Council for Sustainable Development (WBCSD), the Wildlife Conservation Society (WCS), and others.
- The G7 2030 Nature Compact commitment to halt and reverse biodiversity loss by 2030. [ADD]
- The Leaders' Pledge for Nature to reverse biodiversity loss by 2030 for sustainable development
- The 30x30 proposal is spearheaded by the High Ambition Coalition for Nature and People, a growing coalition of 70 countries. It has been incorporated in the action targets of the CBD's first draft of the Post-2020 Global Biodiversity Framework: "Ensure that at least 30 percent globally *of land areas and sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."*
- The Non-State Actors' Call for Governments to Strengthen the Post-2020 Global Biodiversity Framework to secure an equitable, nature positive, net-zero emissions world.
- The Global safety net

The call for integrated action and the targets set are also based on scientific studies demonstrating the potential benefits of addressing climate change and biodiversity. For example, a UNEP World

[42] https://www.naturepositive.org/

[43] Target of the post-2020 global biodiversity framework which builds on the Strategic Plan for Biodiversity 2011-2020 and sets out an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity, ensuring that by 2050 the shared vision of 'living in harmony with nature' is fulfilled.

Conservation Monitoring Centre (WCMC) study[44] found that conserving 30% of land in strategic locations could safeguard 500 gigatonnes of carbon stored in vegetation and soils, around half the world's vulnerable terrestrial carbon stocks, and reduce the extinction risk of nearly 9 out of 10 threatened terrestrial species. Research shows that when prioritizing areas for conservation, accounting for biodiversity and carbon together can secure 95 percent of the biodiversity benefits and nearly 80 percent of the carbon stocks that could be obtained by prioritizing either value alone.

1.2. CLIMATE-BIODIVERSITY NEXUS

1.2.1. Biodiversity to climate

Biodiversity and climate are connected through carbon. "Living organisms control the climate system by regulating the reflectivity of the land surface, altering the concentration of greenhouse gases in the atmosphere, and by influencing the formation of clouds and atmospheric dust. They are the main actors in the global carbon cycle and play a central role in the dynamics of all the major greenhouse gases."[45,46]

[44] Referring to: De Lamo, X. et al. (2020) Strengthening synergies: how action to achieve post-2020 global biodiversity conservation targets can contribute to mitigating climate change. UNEP-WCMC, Cambridge, UK

[45] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

[46] How are the Global Carbon Cycle and Climate Change / Global Warming connected?
The Earth is warmed by the Sun. This warmth is returned from Earth to the atmosphere in the form of heat radiation. Many gases in the atmosphere, including CO2, absorb the Earth's heat energy and radiate in all directions. The energy radiated downward warms the surface and lower atmosphere. Adding more CO2 to the atmosphere means more heat radiation is captured by the atmosphere and radiated back to Earth. (source: Carbon and Climate: Basic information on the major components of the global carbon cycle https://galenmckinley.github.io/CarbonCycle/)

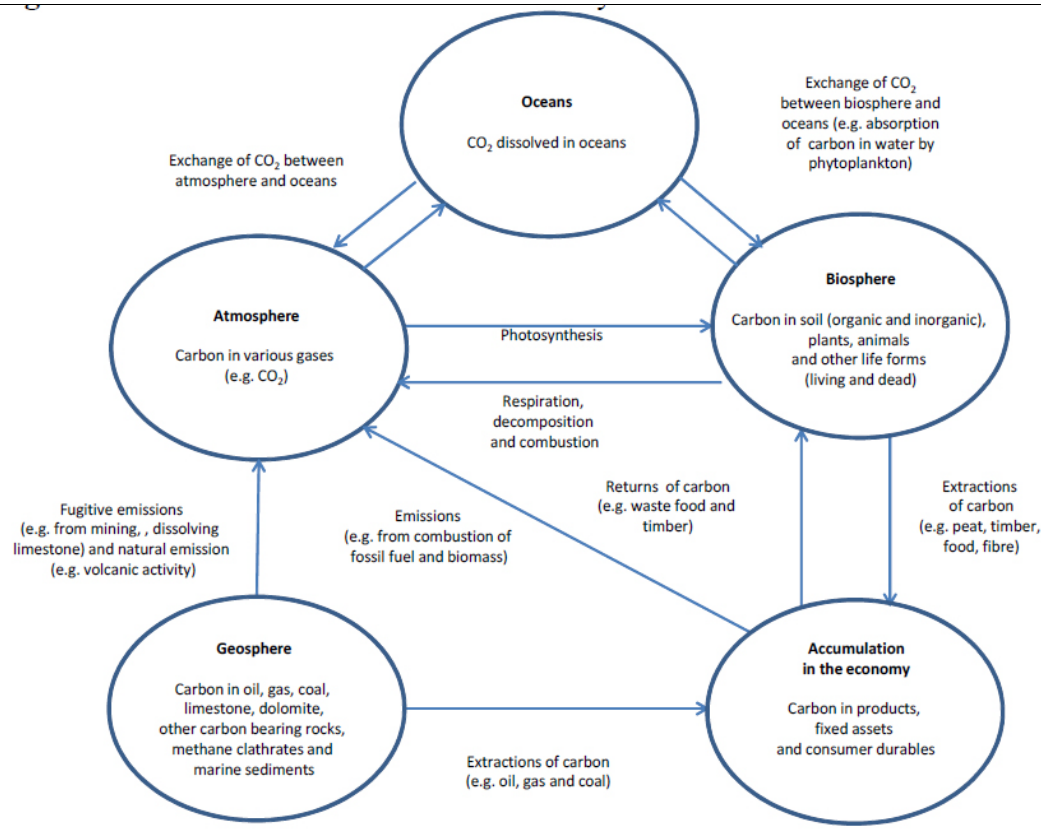

Fig. 5: The main elements of the carbon cycle[47]

The carbon cycle is the flow of carbon (in various forms, such as carbon dioxide or methane) through the atmosphere, ocean, terrestrial biosphere, and lithosphere. The carbon cycle monitors the exchange of carbon throughout the earth's "carbon reservoirs" or carbon sinks which store and transport carbon in many ways. The flow is measured in GtC/year (gigatonnes of carbon per year), and it may be stored in gaseous, liquid, and solid form in the atmosphere, land, and sea.[48]

The land biosphere takes up and releases enormous amounts of carbon each year as it cycles through periods of growth and dormancy. Growth leads to the accumulation of carbon in leaves and stalks, woody parts, roots, and soils. Decay of dead matter, primarily on the ground and in soils, returns carbon to the atmosphere. Because land plants are sensitive to short-term changes in climate that make for the variable quality of growing seasons and are also vulnerable to extreme events such as fire, drought, and flooding, there is substantial year-to-year variability in the magnitude of the carbon uptake by the terrestrial biosphere.

New agricultural land is typically created by cutting down forests. When trees are cut down and burned or left to decompose, carbon goes into the atmosphere.

CO2 dissolves in seawater and then reacts with the water to dissociate into several ions. This disassociation means that the oceans can hold a lot of carbon – 85% of the active reservoir on earth. Cold seawater can hold more CO2 than warm water, so cooling waters tend to take up carbon, and waters that are upwelling and warming (i.e., coastal zones and the tropics) tend to emit carbon.

As humans increase the atmospheric CO2 concentration, more carbon is driven into the oceans. However, because of the chemistry of carbon in seawater, the ability of the ocean to absorb carbon decreases as the concentration increases. Anthropogenic interventions may slow down the large-scale overturning circulation of the ocean and

[47] Vardon, M. (December 2014). Carbon and Ecosystem Accounting (draft). Work undertaken as part of the project 'Advancing the SEEA Experimental Ecosystem Accounting'. This note is part of a series of technical notes, developed as an input to the SEEA Experimental Ecosystem Accounting Technical Guidance, led by the UN Statistics Division, in collaboration with UNEP, and the Secretariat of the CBD.

[48] https://energyeducation.ca/encyclopedia/Carbon_cycle

reduce the efficiency of the ocean sink. There are additional consequences to the ocean's uptake of carbon. CO2 is dissolved in seawater and forms carbonic acid, and so adding more CO2 to the water makes the ocean more acidic. Acidification will damage coral reefs and likely place significant stress on species important to the ocean food chain, particularly in the Southern Ocean.

Life on earth is based on carbon. Carbon is a ubiquitous element on earth. Geocarbon (carbon stored in the geosphere) is essentially inert on geological timescales and are generally stable in the absence of human activity but once extracted cannot be returned except in thousands of years. The rest of the carbon is stored as CO_2 (carbon dioxide) in the atmosphere (2%), as biomass in land plants and soils (5%), as fossil fuels in a variety of geologic reservoirs (8%), and as a collection of ions[49] in the ocean (85%).[50] As noted ocean represents 85% of the active earth's reservoir, but because the ocean takes ~1000 years to mix, this process will take many hundreds to thousands of years.

Carbon should not be confused for the one often used as a short-hand[51] for referring to CO_2 or greenhouse gases in general. Plant and animal tissues are made from carbon. Carbon is the critical element in carbon dioxide,[52] methane, and soot (black C), which trap heat when they occur in excess in the atmosphere. Carbon dioxide is the raw material for photosynthesis, which plants and algae (and bacteria) carry out, providing the energetic currency for life and sequestering carbon above and below ground. Changes in temperature and carbon dioxide alter rates of photosynthesis and fates of carbon within primary producers.

When referring to the flow of carbon in nature through the carbon cycle, carbon is essentially recycled in many different forms throughout its lifetime. At the same time, CO_2 only appears in the carbon cycle as an emission. Future climate warming depends on CO2 sources from human emissions, and CO2 sinks from natural sinks in the ocean and the terrestrial biosphere.

1.2.2. Evidence of climate change impact on biodiversity

Climate change is one of the direct drivers of biodiversity decline but additionally has a 'multiplier effect,' exacerbating the impacts of the other direct drivers. Climate change interacts with and increasingly exacerbates non-climatic stressors, such as habitat loss, invasive species, pollution, disease, and over-exploitation due to compounding effects, such as degrading habitats, increasing disease susceptibility, and changing movement patterns of damage-causing species. At the same time, measures to address non-climatic stressors ('doing everything else better') to maximize the opportunity for wild

[49] CO_2 dissolves in seawater, and then reacts with the water so that it dissociates into several ions.

[50] Carbon and Climate: Basic information on the major components of the global carbon cycle https://galenmckinley.github.io/CarbonCycle/

[51] For example, "carbon accounting" and "low carbon economy" are still used as popular proxies for "GHG accounting" or "low GHG economy".

[52] The atomic weight of a carbon atom is 12 and the atomic weight of oxygen is 16, so the total atomic weight of CO_2 is 44 (12 + (16 * 2) = 44). This means that a quantity of CO_2 can be expressed in terms of the amount of carbon in contains by multiplying the amount of CO_2 by 0.27 (12/44). E.g., 1kg of CO_2 can be expressed as 0.27kg of carbon, as this is the amount of carbon in the CO_2.

organisms and ecosystems to adapt to and survive climate change are necessary for climate-focused actions.

Climate change and its related effects, such as changes in temperature, precipitation, and sea levels, have both direct and indirect effects on species distribution, their physiology and behavior, and the modification of habitats.[53]

Impacts of anthropogenic climate change have been documented in plants and animals across marine, terrestrial, and freshwater realms. They span all principal biomes, from rainforests and deserts to wetlands and coastal marine to the deep. Climate change impacts species at various scales (from genes and individuals to populations). They may occur at habitat and ecosystem scales through changes in interspecies interactions (e.g., competition, predation, disease), community composition, ecosystem function, and ecosystem structure.
Observed climate change impacts on biodiversity include direct alteration of abiotic conditions, such as shifts in climatic features (e.g., temperatures, seasonality, extreme weather), the physical environment (e.g., sea level, glacial extent, fire frequency, oxygen concentration), and atmospheric greenhouse gas concentrations (e.g., CO2).
At the individual organism level, climate change impacts may appear, such as changes in growth rate, reproductive success, behavior timing, disease susceptibility, or traits such as body size.
This may scale up to changes in population size, age structure, sex ratio, or gene flow between subpopulations at the population level. Such impacts may translate to species-level changes in abundance, range size and location, level of range fragmentation, or changes in genetic diversity. These changes may increase or decrease the species' extinction risk or have varying effects in different parts of the species range. The resulting impacts on interspecies interactions include shifts in interactions between competitors, predators, and prey and those relying on pollination, biotic pollination, parasitism, and symbioses.[54]

More specific impacts can be documented per ecosystem type "since terrestrial, freshwater and marine systems are controlled by different biophysical properties and differ in their spatial structure, biodiversity responses may be fundamentally different." Some ecosystems are particularly vulnerable to climate change, e.g., coral reefs.

Projected impacts

Rapid climate change can be a key driver of mass extinctions, capable of eliminating up to 90% of all species, raising concerns about the adaptive potential of extant species to ongoing and future climate change. Though empirical evidence for current climate change-driven extinctions is still limited, there is enough evidence to indicate that ongoing climate change is driving geographic range shifts in species,

[53] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.
[54] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

altering phenology[55] and migration patterns and the availability of suitable habitat for species, disrupting key ecological interactions in communities.

Climate change impacts earth's biodiversity by altering species ranges and abundances, reshuffling biological communities, restructuring food webs, and altering ecosystem functions.[56] As climate change progresses, organisms' distribution, functioning, interactions, and thus ecosystems are increasingly altered.

Invasive species are projected to benefit from climate change as it accelerates colonization rates through adaptive migration, and weakens the integrity of in situ biotic assemblages, thus raising the likelihood of colonizing species thriving in new locations and novel climates. If the invading species is a pathogen, the potential for new diseases may increase. Changing climatic conditions also lead to shifts in disease vectors (e.g., malaria mosquitoes and ticks) and their potential release from natural controls.[57]

Changes in species composition and the reorganization of local and regional biological communities have consequences for biophysical and biochemical processes, with implications for climate and regional energy, nutrient, and water cycles.

Table 2: Projected impacts under different climate scenarios[58]

Under a global warming scenario of 1.5°C warming above pre-industrial levels	Loss of over half of the climatically determined geographic range in 6% of insects, 8% of plants, and 4% of vertebrates.
For global warming of 2°C	Loss of over half of the climatically determined geographic range in 18% of insects, 16% of plants, and 8% of vertebrates. [59] 5% species at risk of climate-related extinction[60]
Future warming of 3.2°C	Loss of more than half of the historical geographic range in 49% of insects, 44% of plants, and 26% of vertebrates
Future warming of 4.3°C	16% species at risk of climate-related extinction[61]
Under warming scenarios associated with little successful climate mitigation (RCP 8.5)	Abrupt disruption of ecological structure, function, and services is expected in tropical marine systems by 2030, followed by tropical rain forests and higher latitude systems by 2050

Climate has altered and will continue to alter ecosystem functions' provision, timing, and location.

[55] Phenology is the study of periodic events in biological life cycles and how these are influenced by seasonal and inter-annual variations in climate, as well as habitat factors.

[56] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

[57] IPBES and IPCC. (June 2021).

[58] IPBES and IPCC. (June 2021).

[59] IPBES and IPCC. (June 2021).

[60] IPBES. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

[61] IPBES. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

1.2.3. Need for an integrated approach to biodiversity and climate crises

"Though biodiversity loss and climate change are recognized as two of the most pressing issues currently and though they are recognized as interconnected in both scientific and policy-making circles, they are largely addressed in their domains." [62]

"This functional separation creates a risk of incompletely identifying, understanding, and dealing with the connections between the two. In the worst case, it may lead to taking actions that inadvertently prevent the solution of one or the other, or both issues."[63]

"Human-caused climate change is increasingly threatening nature and its contributions to people, including its ability to mitigate climate change. Changes in biodiversity, in turn, affect climate, especially through impacts on nitrogen, carbon and water cycles."[64] In other words, biodiversity and climate change mutually reinforce each other. Moreover, climate change is expected to be the no. one threat to biodiversity in the following decades.[65]

The connection among ecosystems, climate change, and biodiversity and the need to consider them jointly was recognized in the United Nations Framework Convention on Climate Change (UNFCCC's) CoP25 decision of December 2019 that underlines **"the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner."**[66,67] Also according to the UNEP's Adaptation Gap report 2020 "A majority of countries' nationally determined contributions (NDCs) and national adaptation plans (NAPs) acknowledge the vulnerability of ecosystems to climate change, as well as their ability to effectively reduce climate impacts." At the same time, AGR5 recognizes that the substantial impacts of high-end climate change on biodiversity can limit the effectiveness of Nature-based Solutions and increase societal vulnerability, thus reducing adaptation choices.

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62 IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

63 IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change".

64 IPBES and IPCC. (June 2021) "Tackling biodiversity and climate change."

65 IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change".

66 The overarching decision titled "Chile Madrid Time for Action", proposed for adoption by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at its second session. (source: SEEA, 2021)

67 Moreover, IPBES, at its 7th session in May 2019, adopted a new work programme up to 2030 and agreed to the preparation of a technical paper on biodiversity and climate change, based on the material referred to or contained in the assessment reports of IPBES and, on an exceptional basis, the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), with a view to informing, inter alia, the Conference of the Parties to the Convention on Biological Diversity at its fifteenth meeting and the Conference of the Parties to the United Nations Framework Convention on Climate Change at its twenty-sixth session. (source: IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

The importance of integrated solutions for climate and biodiversity re-emerged[68] as a very recent discourse with the publication of an IPBES-IPCC report[69] on biodiversity and climate change in June 2021. The Intergovernmental Science-policy Platform on Biodiversity & Ecosystems Services (IPBES) and the Intergovernmental Panel on Climate Change (IPCC), in a first-ever collaboration,[70] organized a joint workshop. "IPBES-IPCC co-sponsored workshop biodiversity and climate change"[71] to explore these complex and multiple connections between climate and biodiversity.

The scientific outcome report of the IPBES-IPCC workshop reaffirmed the urgency of both climate and biodiversity action: "Without urgent action to halt and reverse biodiversity loss, reductions in greenhouse gas emissions to limit warming to close to 1.5°C or even 2°C will not be achieved."[72]

"Actions to enhance the adaptive capacity of ecosystems are placed at risk by unabated climate change exceeding adaptation limits -highlighting the importance of keeping climate warming well below 2°C- and by high levels of other pressures, such as land-use, overexploitation or pollution."[73]

The report explores the observed and projected impacts of climate change on biodiversity and why actions for climate change mitigation or adaptation should be prioritized to avoid the adverse effects on biodiversity. It refers to the risks entailed into narrow-focused measures to climate change mitigation or adaptation (technical and technology-based measures) and limited time horizon (short-term) land-based solutions. The report provides a series of climate actions with long-term impacts on biodiversity. It suggests a combined approach to climate biodiversity to safeguard for win-win solutions and avoid future lock-ins.

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[68] The Adaptation Gap report 2020 mentions that "A majority of countries' nationally determined contributions (NDCs) and national adaptation plans (NAPs) acknowledge the vulnerability of ecosystems to climate change, as well as their ability to effectively reduce climate impacts."

[69] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change".

[70] It is worth mentioning that mechanisms for collaboration are also in place between the two conventions, the CBD and UNFCCC to promote synergies between their respective frameworks. An example is the establishment of an Ad Hoc Technical Expert Group on Biodiversity and Climate Change by the CBD COP in 2001, including scientists involved in the IPCC process and experts from the UNFCCC process and its secretariat. The expert group's mission was to carry out an assessment of the interlinkages between biodiversity and climate change and completed the "Interlinkages between Biological Diversity and Climate Change: Advice on the integration of biodiversity considerations into the implementation of the United Nations Framework Convention on Climate Change and its Kyoto Protocol report in October 2003. (source: https://www.cbd.int/cooperation/activities.shtml)

[71] In December 2020, 50 of the world's leading biodiversity and climate experts, selected by a 12-person Scientific Steering Committee assembled by IPBES and IPCC, participated in a four-day virtual workshop to examine the synergies and trade-offs between biodiversity protection and climate change mitigation and adaptation. This represents the first-ever collaboration between the two intergovernmental science-policy bodies. https://ipbes.net/events/launch-ipbes-ipcc-co-sponsored-workshop-report-biodiversity-and-climate-change

[72] IPBES-IPCC Report, and also article Bridging COP26 and COP15: EU highlights the need to tackle the nature and climate crises together, 29 October 2021.https://ec.europa.eu/environment/news/bridging-cop26-and-cop15-2021-10-29_en

[73] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change." pg. 15.

This perspective is considered essential to provide a complete overview of climate change risks and mitigation and adaptation's potential unintended trade-offs to ecosystems and biodiversity, as in the case of biofuel crop production, afforestation of biodiversity-rich habitats, or monocultures. Envision must highlight and assess these risks in climate action projects as a sustainability assessment tool. A prioritization tool for the right projects should enable the identification of win-win projects away from narrowly focused solutions for rapid outcomes, for example, rapid carbon sequestration to reach short-term targets.

An integrated approach also must be established in scenario-analysis that considers:

- the impacts and risks of plausible future changes in climate for terrestrial, freshwater, and marine biodiversity, nature's contributions to people and quality of life,
- feedback from plausible changes in biodiversity on climate characteristics and climate change.

As explained in the IPBES-IPCC report, scenarios tend to have a specific Climate Change mitigation focus and pay less attention to biodiversity, e.g., the Deep Decarbonization Pathways Project primarily focuses on energy sources. Moreover, current scenarios used by IPCC when referring to the contribution of natural carbon sequestration enhancement actions do not differentiate between natural forest regrowth, reforestation with plantations, or afforestation of land not previously tree-covered, thus making assessing biodiversity impacts difficult.

However, ecosystems are complex, with interdependent components and processes. There will always be a level of uncertainty in how they will react to specific interventions or other external changes. The complexity of this relationship is outlined by different series of examples of interactions that the report describes that vary based on ecosystem type, location, condition, extent, etc.

On the one hand, developing scenarios for both biodiversity and climate entails the challenge of increasing complexity, nonlinearity, and uncertainty. On the other hand, NbS should be designed and monitored to minimize and mitigate unanticipated risks that might undermine the ecological foundations of the solution itself. Therefore, there is a need for a new science-practice relationship to bring about purposeful interventions to initiate and accelerate the transition to a new paradigm.

1.2.4. Bridging COP26 and COP15: 2021 as a landmark year for an integrated approach to climate-biodiversity crises

The year 2021 is a landmark year to make decisions on the two most pressing global challenges with two Conferences of Parties held at short time intervals: the UN Biodiversity Conference (COP15) in October 2021 (and April 25 to May 8, 2022) and the UN Climate Change Conference (COP26) in November 2021. COP15 is expected to result in a negotiated new Post-2020 Biodiversity Framework as a successor to the 2010 CBD Aichi Targets for addressing biodiversity loss. It is a critical opportunity to put Nature-based Solutions as part of the international framework for global environmental action to 2030 and beyond.

The first phase of COP15 resulted in the new Kumming Declaration[74] under which 99 ministers, nine heads of state, and the heads of delegations commit to negotiate, adopt and implement an effective post-2020 Global Biodiversity Framework in 2022.[75]

COP26 aimed to review progress towards meeting the Paris Agreement climate targets. The urgency for improved biodiversity reporting is given added significance by the COP26, where one of four goals will be to ensure adaptation that protects natural habitats and restores ecosystems. The UK has stressed that one of its objectives as COP 26 president is to maximize the potential of nature-based solutions to enhance prosperity, reduce emissions, and safeguard resilience. It builds on the outcomes of COP 25, held in Madrid in 2019, which, in its decisions, underlined "the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner."

A pairing of nature-positive targets and Paris agreement climate targets was pursued. The CBD post-2020 framework and next round of biodiversity targets need to be defined with climate impacts and potential for climate mitigation and adaptation in mind. Similarly, the UNFCCC Paris Agreement negotiations need to reflect and support the delivery of national commitments to the CBD and SDGs. In this context, the national science academies of the G7 nations, Science 7 (S7), 2021, advocated those countries be encouraged through the respective conventions to coordinate and integrate the currently separate National Climate Plans and National Biodiversity Strategies.[76]

The COP26 negotiations resulted in the adoption of the Glasgow Climate Pact. The pact and other commitments made during the summit fall short of limiting global warming to the 1.5 degrees Celsius stretch target of the 2015 Paris Agreement, but full implementation of the commitments made throughout COP26 could limit heating to 1.8 degrees. Importantly, several nature-related mentions feature in the final agreed text of the Glasgow Climate Pact. In the Glasgow Climate Pact the explicit connection between the climate and nature agendas is more pronounced than it was in the Paris Agreement. Moreover, an increased number of individual countries' climate plans now include nature-based solutions, from the previous 82% to 92%.[77]

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[74] CBD. (October 2021).Kunming Declaration "Ecological Civilization: Building a shared future for all life on earth" Among others the declaration commits to "Increase the application of ecosystem-based approaches to address biodiversity loss, restore degraded ecosystems, boost resilience, mitigate and adapt to climate change, support sustainable food production, promote health, and contribute to addressing other challenges, enhancing One Health and other holistic approaches and ensuring benefits across economic, social, and environmental dimensions of sustainable development, through robust safeguards for environmental and social protection, highlighting that such ecosystem-based approaches do not replace the priority actions needed to urgently reduce greenhouse gas emissions in a way that is consistent with the goals of the Paris Agreement"

[75] TNFD. (October 2021). "After COP15: Market leadership instrumental for global biodiversity agreement."

[76] European Academies Science Advisory Council (EASAC). (August 2021). Key Messages from European Science Academies for UNFCCC COP26 and CBD COP15: The urgency of the climate and biodiversity crises requires closer coordination between UNFCCC and CBD.

[77] TNFD. (November 2021). "After COP26: Nature positive set to become key component of net zero."

1.2.5. Biodiversity as an integral component of climate action

"There is no climate solution without the full contribution from nature." Nature can provide up to 37% of mitigation needed to meet the goal of the Paris climate agreement,[78] about one-third of the climate solution.[79]

Carbon sequestration is the process of storing carbon in a carbon pool. It flows from the atmosphere to the biosphere ecosystem based on various processes. It is essential to distinguish between short-term flows (e.g., diurnal exchange of CO2 between vegetation, atmosphere, and long-term sequestration).

Long-term sequestration varies per ecosystem type and condition. Different types of ecosystems have different qualities of carbon stocks. On the one hand, this indicates the complexity involved in the interrelation of biodiversity, and the services ecosystems provide. On the other hand, how critical is the condition of ecosystems for them to serve as helpful carbon sinks? Biodiversity decline, therefore, can undermine climate change mitigation efforts.

Ecosystems such as forests, rangelands, croplands, peatlands, and wetlands represent globally significant carbon stores. Their conservation, restoration, and sustainable use are included as a part of many Intended Nationally Determined Contributions and are therefore a critical element for the fulfillment of the Paris Agreement.[80]

Biodiversity and healthy ecosystems are also essential resources for increasing resilience and reducing the risks and damages associated with the negative impacts of climate change. They can serve as natural buffers against extreme climate and weather events such as changing patterns of rainfalls, droughts, storms, and other disasters. [81]

1.3. ALIGNMENT OF BIODIVERSITY TARGETS TO THE 2030 AGENDA SDGs

Several studies on SDG interactions have demonstrated that actions or inactions toward specific goals affect progress, positively or negatively, towards other goals. Among the multiple interactions between SDGs, the two biodiversity-focused SDGs, SDG 14 (Life below water) and SDG 15 (Life on land) appear particularly important for sustainable development, acting as multipliers of co-benefits across all goals and buffering other negative interactions.[82]

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78 COP26: A Chance to Address the Interconnected Crises of Climate Change and Biodiversity Loss. https://www.campaignfornature.org/cop26-hub

79 September 2019 speech on Climate action by Ex. Director of UNEP Inger Andersen

80 Secretariat of the Convention on Biological diversity (CBD), Food and Agriculture Organization of the United Nations, World Bank, United Nations Environment Programme, and United Nations Development Programme. (December 2016). "Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note."

81 Secretariat of the Convention on Biological diversity (CBD), Food and Agriculture Organization of the United Nations, World Bank, United Nations Environment Programme, and United Nations Development Programme. (December 2016). "Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note."

82 Obrecht, A., et al. (February 2021). "Achieving the SDGs with Biodiversity."

According to studies, measures to implement SDGs 14 and 15 are most likely to generate multiple co-benefits (opportunities) while entailing relatively small risks of trade-offs. [83]

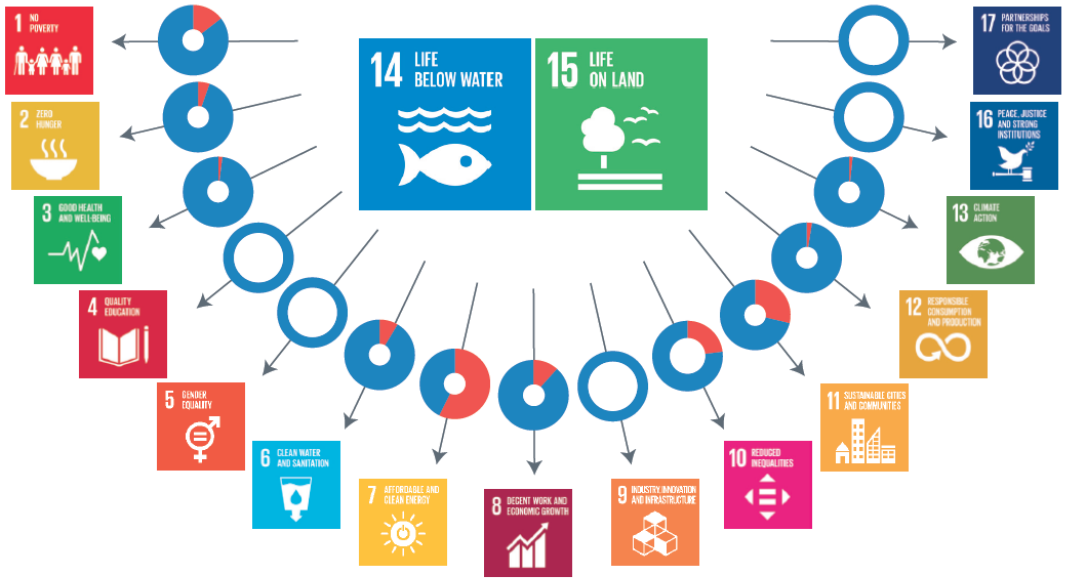

Figure 2: Contribution of Life below Water and of Life on Land (SDGs 14 and 15) to other SDGs. The data is the result of a systematic compilation of the current state of knowledge about interactions among the SDGs, in terms of co-benefits (blue) and trade-offs (red). The compilation is based on a total of 65 global assessments (UN reports and international scientific assessments), as well as 112 scientific articles published since 2015 with explicit reference to the SDGs. The slim donuts show either gaps in knowledge or weaker interactions.[21, 23]

Fig. 6: Contribution of Life below Water and Life on Land (SDGs 14 and 15) to other SDGs.[84]

[83] Obrecht, A., et al. (February 2021). "Achieving the SDGs with Biodiversity."

[84] Obrecht, A., et al. (February 2021). "Achieving the SDGs with Biodiversity."

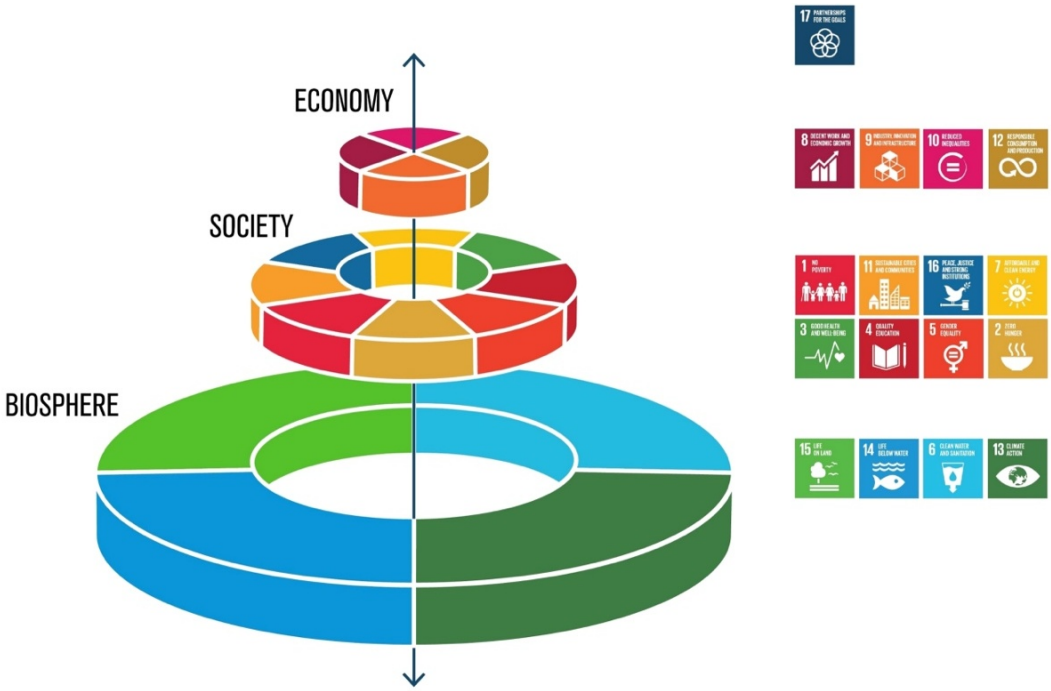

Fig.7: The three dimensions of the SDGs
Illustration highlighting biosphere as the foundation for societies, economies, and quality of life[85].

The foundational role of biodiversity and healthy ecosystems to sustainable development reaffirms the need to reverse biodiversity decline and integrate biodiversity into 2030 Agenda implementation actions. Without adequate measures to conserve biodiversity and sustainably use its components, the 2030 Agenda for Sustainable Development will not be achievable.[86] Moreover, the SDGs call for a balanced, mutually supportive approach so that activities to implement specific goals do not cause adverse impacts on biodiversity and ecosystems.

[85] https://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html

[86] Secretariat of the Convention on Biological diversity (CBD), Food and Agriculture Organization of the United Nations, World Bank, United Nations Environment Programme, and United Nations Development Programme. (December 2016). "Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note."
An analysis of how biodiversity supports the achievement of all SDGs, published jointly by the Secretariat of the Convention on Biological diversity (CBD), the Food and Agriculture Organization of the United Nations, the World Bank, the United Nations Environment Programme, and the United Nations Development Programme.

Fig. 8: Biodiversity and conservation benefits to SDGs
The graph highlights the benefits of the two biodiversity-focused SDGs (SDG14 and SDG15) to the rest of the SDGs
Source: UNEP WCMC Creating a Nature-Positive Future for People and Planet

An analysis of how biodiversity supports the achievement of all SDGs was jointly published by CBD, the UN Food and Agriculture Organization, the World Bank, UNEP, and the UN Development Programme. The analysis presented a mapping of the linkages between the SDGs and the Strategic Plan for Biodiversity 2011-2020, shown in the table below:

Table 3: Summary of linkages between Aichi Biodiversity targets & SDGs[87]

[87] Table by authors adapted from table 'Summary of linkages between SDGs and Aichi Biodiversity Targets'. Source: Secretariat of the Convention on Biological diversity (CBD), Food and Agriculture Organization of the United Nations, World Bank, United Nations Environment Programme, and United Nations Development Programme. (December 2016). "Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note."

Similar work has been conducted recently for the linkages between the Post-2020 Global Biodiversity Framework and the SDGs, highlighting the alignment of biodiversity goals and sustainable development goals.

Table 4: Linkages between the Post-2020 Global Biodiversity Framework and 2030 Agenda for Sustainable Development[88]

2020	SUSTAINABLE DEVELOPMENT GOALS
Goal A The integrity of all ecosystems is enhanced, with an increase of at least 15 per cent in the area, connectivity and integrity of natural ecosystems, supporting healthy and resilient populations of all species, the rate of extinctions has been reduced at least tenfold, and the risk of species extinctions across all taxonomic and functional groups, is halved, and genetic diversity of wild and domesticated species is safeguarded, with at least 90 per cent of genetic diversity within all species maintained.	
Goal B Nature's contributions to people are valued, maintained or enhanced through conservation and sustainable use supporting the global development agenda for the benefit of all;	
Goal C The benefits from the utilization of genetic resources are shared fairly and equitably, with a substantial increase in both monetary and non-monetary benefits shared, including for the conservation and sustainable use of biodiversity.	
Goal D The gap between available financial and other means of implementation, and those necessary to achieve the 2050 Vision, is closed.	

[88] Table by authors adapted from: CBD Subsidiary Body on Scientific, Technical and Technological Advice (February 2021). "Linkages between the Post-2020 Global Biodiversity Framework and 2030 Agenda for Sustainable Development: Note by the Executive Secretary."

As for SDG 13 (Climate Action):

Table 5: Biodiversity targets contributing to SDG 13. Take urgent action to combat climate change & its impacts

13 CLIMATE ACTION	Aichi Targets Biodiversity values integrated Habitat loss halved or reduced Ecosystems vulnerable to climate change Ecosystem services Ecosystem restoration and resilience Biodiversity strategies and action plans	post-2020 targets **Target 1. Biodiversity-inclusive planning** **Target 2. Ecosystem restoration** **Target 8. Biodiversity & climate change action** **Target 11. Nature's contributions maintained and enhanced** **Target 14. Biodiversity values fully integrated**

1.4. NbS AS AN INTEGRATED BIODIVERSITY-CLIMATE SOLUTION

Nature-based Solutions (NbS) is an approach that bridges climate and biodiversity actions. NbS can play an essential role in climate mitigation, but the extent is debated, and they can only be effective with ambitious reductions in all human-caused GHG emissions. Nature-based solutions can be most effective when planned for longevity and not narrowly focused on rapid carbon sequestration.[89]

The term Nature-based solutions was first coined during the UNFCCC negotiations in 2009[90] and was formally defined by IUCN as "Actions to protect, sustainably use, manage and restore natural or modified ecosystems, which address societal challenges, effectively and adaptively, providing human wellbeing and biodiversity benefits" (IUCN). The Nature-based Solution concept builds on and supports other closely related concepts, such as the ecosystem approach, ecosystem services, ecosystem-based adaptation/mitigation, and green and blue infrastructure.[91]

NbS can be implemented alone or integrated with other solutions (e.g., technological and engineering solutions).

Three main objectives are identified for climate- biodiversity nexus:

[89] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."pg.16.

[90] IUCN. (2016). "Defining Nature-based Solutions." Resolution of the World Conservation Congress at its session in Hawai'i, United States of America, 1-10 September 2016.

[91] Naumann, S. and Davis M. (April 2020). "Biodiversity and Nature-based Solutions: Analysis of EU-funded projects." Independent Expert Report prepared for the European Commission.

- Need to maintain ecological function and ecosystem services.
- Maximize carbon sequestration by natural ecosystems.
- Adapt to the impacts of climate change.

Nature conservation is embedded in the concept of NbS. The top priority is protecting and restoring carbon-rich ecosystems from a joint climate change- biodiversity perspective.[92]

Ecosystem restoration is the process of assisting (initiating or accelerating) the recovery of an ecosystem that has been degraded, damaged, or destroyed by human activity. However restoration is not a substitute for conservation, neither can be used to justify destruction or unsustainable use. While restoration can successfully reestablish biodiversity, structure and function to a degraded ecosystem, it may not succeed in reestablishing the full extent of the original ecosystem's structure and function.[93]

Ecosystem restoration also enhances resilience of biodiversity in the face of climate change. For example, "restoration with a variety of native species ensures ecosystem resilience in the face of climate change and has benefits for biodiversity, but also relies on novel species assemblages to match future climatic conditions." Measures narrowly focusing on protection and restoration of biodiversity have generally important knock-on benefits for climate change mitigation, but those benefits may be sub-optimal compared to measures that account for both biodiversity and climate.[94]

It is worth adding that "in the face of climate change, the restoration will be much about managing change, being appropriate to future conditions, while a return to a historical state of many indicators will be hard or impossible to achieve".[95] According to the IPBES-IPCC joint report, "the term "rehabilitation" may be more appropriate than "restoration," in the context of climate change, where re-establishing the pre-existing conditions may not be possible, but an enhanced state and functions appropriate to shifting conditions is feasible."[96] Increasingly, restoration is viewed from a perspective of restoring functions and societal benefits of natural habitat, and under climate change, for carbon sequestration, e.g., rebuilding carbon stocks. [97]

NbS are recognized for their significant potential to generate climate-biodiversity co-benefits. However, there has been concern that potentially everything can be seen as an NbS without clear criteria. For example, by some standards, a traditional protected area would be an NbS, while others would not because it is aimed at conservation, not human-focused challenges (IUCN, 2020). The International

[92] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."pg.59.

[93] https://www.ser-rrc.org/what-is-ecological-restoration/

[94] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."

[95] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change." pg.64.

[96] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."pg.47.

[97] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."pg.47.

Union for Conservation of Nature and Natural Resources (IUCN) has published the IUCN Global Standard of 2020 to address this concern.[98] According to the IUCN Standard, **NbS must "result in a net gain to biodiversity and ecosystem integrity."** Consequently, each ecosystem type (ocean, land, inland aquatic ecosystems, urban, etc.) would require NbS actions suitable to the specific risks and opportunities within those ecosystem functions.[99]

1.5. NbS CONTRIBUTION ANALYZED THROUGH THE ECOSYSTEM APPROACH

1.5.1. The ecosystem approach

"Mainstreaming of biodiversity into climate and vice versa has been promoted as one way to achieve multiple goals."

Nature's relation and multi-benefit potential for climate change mitigation and adaptation, as well as human wellbeing in general, is better understood through the concept of ecosystem services,[100] the flows of ecosystem benefits enabling human activities, e.g., timber, fiber, pollination, water regulation, climate regulation, recreation, mental health. The ecosystem services concept provides a starting point towards defining, monitoring, and valuing such services. A key goal is to make explicit the benefits of ecosystems. The Millennium Ecosystem Assessment brought the concept into widespread use, a global initiative set up in 1999 to assess how ecosystem changes would affect human wellbeing.

The 'ecosystem' approach has been endorsed by the Convention on Biological Diversity (CBD) at the fifth meeting of the Conference of Parties (COP5, 2000). The CBD states that "the ecosystem approach is a strategy for integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way." An ecosystem approach is based on applying appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment.[101] Ecosystem services were part of CBD's Aichi Biodiversity targets and also part of the vision and targets of the CBD's post-2020 Global Biodiversity Framework.

Table 6: Explicit reference to ecosystem services/ or nature's contributions and climate change mitigation and adaptation in global biodiversity targets

In Aichi Biodiversity Targets	In the Post-2020 Biodiversity framework
Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services Target 14: By 2020, ecosystems that provide essential	*"The vision of the framework is a world of living in harmony with nature where: "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining*

[98] IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN.

[99] IPBES and IPCC. (June 2021). "Scientific outcome of the IPBES- IPCC co-sponsored workshop on biodiversity and climate change."pg.153.

[100] Ecosystem services are a central component of the 'landscape as infrastructure' approach presented and documented in the Zofnass program publication 'Prof. S.N. Pollalis (2016) Planning Sustainable Cities: An infrastructure-based approach." Landscape was analyzed in terms of provision of services (ecosystem services), a demand-supply perspective.

[101] https://www.cbd.int/decision/cop/?id=7148

services, including services related to water, and contribute to health, livelihoods, and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable. Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and combating desertification. Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	*ecosystem services, sustaining a healthy planet and delivering benefits essential for all people."* **Goal B** Nature's contributions to people are valued, maintained, or enhanced through conservation and sustainable use supporting the global development agenda for the benefit of all; Target 8: Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation through ecosystem-based approaches, contribute at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity. Target 11: Maintain and enhance nature's contributions to the regulation of air quality, quality and quantity of water, and protection from hazards and extreme events for all people.

It is of interest to the research to enable an analysis of how the Envision assessment framework and its Natural World (NW) category treat ecosystems and environment: as externalities (as in the case for example of the traditional EIA) therefore only assesses the impact of development on them or also as vehicles for development. A growing literature supports that assessing the performance of nature-based solutions should be ecosystem service-based.

At this point, it is essential to clarify differences between terms encountered in literature, such as ecosystem functions and ecosystem services.[102]

Ecosystem functions are defined as the capacity or potential of ecosystems to deliver ecosystem services. Ecosystem services are, in turn, derived from ecosystem functions and represent the realized flow of services for which there is demand.[103] Ecosystem functions are a subset of the interactions between biophysical structures, biodiversity, and ecosystem processes that underpin the capacity of an ecosystem to provide ecosystem services.[104] The capacity of natural processes and components to provide goods and services that satisfy human needs is direct or indirect. **Using this definition, ecosystems functions are best conceived as a subset of ecological processes and ecosystem structures.** Each function results from the natural processes of the total ecological sub-system of which it is a part.[105] An intrinsic ecosystem characteristic is related to conditions and processes whereby an

[102] Ecosystem function is a term used in the Envision manual.

[103] Maes, J.et al. (2018) Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg.

[104] TEEB. (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB.

[105] De Groot, R., Wilson A., M. and Boumans, M.J., R. (June 2002). "A typology for the classification, description and valuation of ecosystem functions, goods and services." *Ecological Economics* Volume 41, Issue 3, Pages 393-408 (Special Issue on "The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives")

ecosystem maintains its integrity (primary productivity, food chain, biogeochemical cycles). Ecosystem functions include decomposition, production, nutrient cycling, and fluxes of nutrients and energy.[106]

Ecosystem services refer to the flows of benefits that ecosystems make to people (e.g., timber, fiber, pollination, water regulation, climate regulation, recreation, mental health), enabling human activities, including the operation of businesses.

In contrast to ecosystem functions, ecosystem services imply access and demand by humans.[107] According to De Groot et al., "the concept of ecosystem goods and services is **inherently anthropocentric**: it is the presence of human beings as valuing agents that enables the translation of basic ecological structures and processes into value-laden entities."

1.5.2. Biodiversity and Ecosystem services

Literature shows that the connection between biodiversity and ecosystem services has been the subject of research. Apart from showing the links between biodiversity and ES, the research also aimed to respond to the question 'does the protection of ecosystem services guarantee biodiversity?'

The links between biodiversity and ecosystems services have been studied to provide clear information on how biodiversity underpins these services, their demand, the capacity of ecosystems to provide them, and the pressures impairing this capacity.

Biodiversity influences the functioning and productivity of ecosystems, acting as an enabling asset that is essential for and underpins final ecosystem services. Greater biodiversity generally results in higher quality, quantity, and resilience of ecosystems and their services. For example, species abundance, diversity, or key species in a specific ecosystem can help maintain the ecosystem functioning and resilience and the related provision of ecosystem services[108]. Therefore, the worldwide degradation of ecosystems also reduces their services, including carbon sequestration.

Ecosystems are shaped by the interaction of communities of living organisms with the abiotic environment. Biodiversity is the living component of natural capital. It plays a key role in ecosystems' structural setup, essential to maintaining basic ecosystem processes and supporting ecosystem functions.[109]

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[106] Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment." Island Press. A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment

[107] European Commission. (April 2013). "Mapping and Assessment of Ecosystems and their Services An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020." Discussion paper.

[108] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[109] European Commission. (April 2013). "Mapping and Assessment of Ecosystems and their Services An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020." Discussion paper.

A common criticism of the concept of ecosystem services is that its anthropocentric focus excludes the idea of ecosystems and biodiversity as inherently valuable, beyond human needs.[110] Many ecosystem services-based approaches are built on the premise that ecosystem services depend on biodiversity, as in the case of the EU Mapping and Assessment of Ecosystems and their Services (MAES) project. MAES depicts in a graph the different roles of biodiversity in supporting ecosystem functions and services:

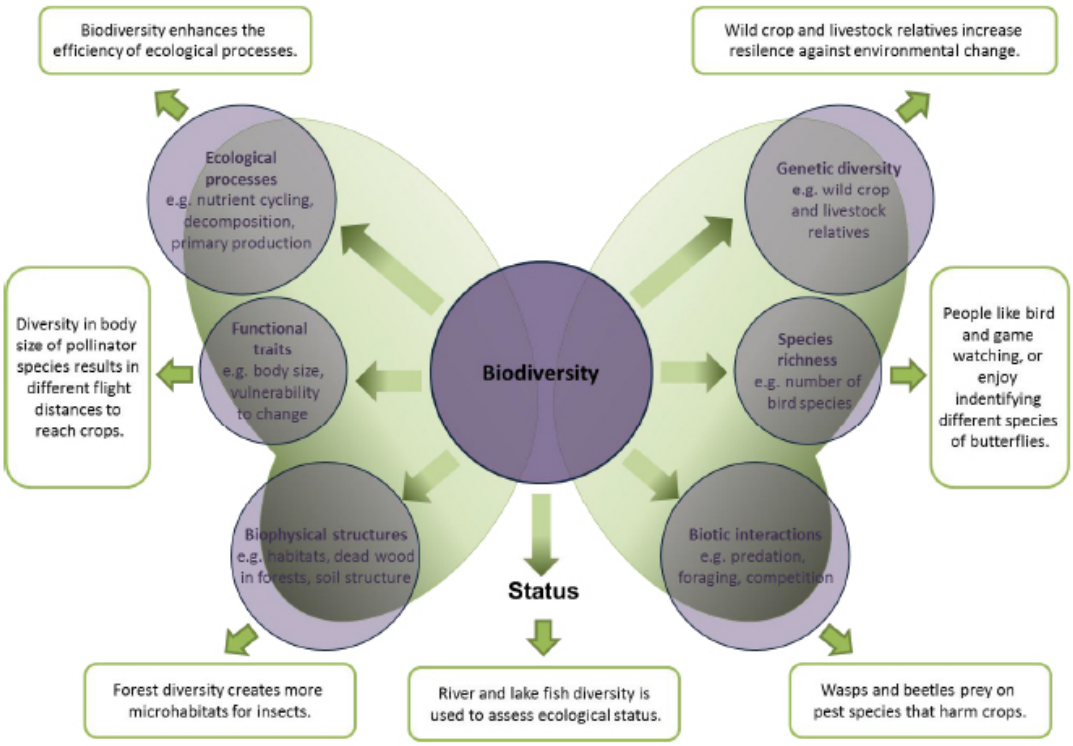

Fig. 9:The multi-faceted role of biodiversity in supporting the delivery of ecosystem services and assessing the status of ecosystems (source: MAES, 2013)

The left wing contains three dimensions of biodiversity that contribute to ecosystem functioning:

i. Biodiversity enhances the **efficiency of ecological processes** such as primary production and decomposition. These processes are key determinants of ecosystem functions.
ii. **Functional diversity**, the variation in the degree of the expression of multiple functional traits, is a second important determinant of ecosystem functioning. Functional traits define species in terms of their ecological roles - how they interact with the environment and other species. (For instance, the body size of pollinator species and their different tolerance to a minimum temperature increase the distance range and the temperature interval, respectively, for which wild pollination of crops can occur).

The butterfly's right wing contains three dimensions of biodiversity that contribute to ecosystem functioning but, importantly, also directly deliver ecosystem services.

i. **Genetic diversity** is the diversity of the gene pool of single species. Different varieties and wild crop and livestock relatives are crucial to maintaining a genetically diverse stock. This diversity makes food production systems more resilient against future environmental change or diseases – the probability that some varieties are adapted to future conditions increases with diversity.
ii. **Species richness** (or the total number of species) and taxonomic diversity (the total number of species of certain groups, e.g., the total number of mammals) is often used as an indicator for biodiversity.
iii. **The diversity of specific biotic interactions** in a food web or species networks such as predation and

[110] European Commission. (May 2015). Science for Environmental Policy In-Depth Report: Ecosystem Services and Biodiversity.

iii. Biodiversity, particularly plant **species diversity**, has a vital role in structuring habitats, ecosystems, and landscapes, which is necessary for many other species, and hence ecosystem services, to exist.	foraging provides, in some cases, a regulating service. (Bees, when foraging on nectar carrying plants, help pollinate crops. Predatory insects help keep pests on crops under control.)[111]

There is a connection between ecosystem conditions and the services they deliver. In a narrow sense, the sustainability of the production of a particular ecosystem service can refer simply to whether the biological potential of the ecosystem to sustain the yield of that service (e.g., food production) is being maintained.[112] **The condition of an ecosystem is usually used as a surrogate for its capacity to deliver ecosystem services**.[113]

The MAES project also illustrates the above connection in a simplified conceptual model that used in each assessment to guide the selection of indicators for its assessment.

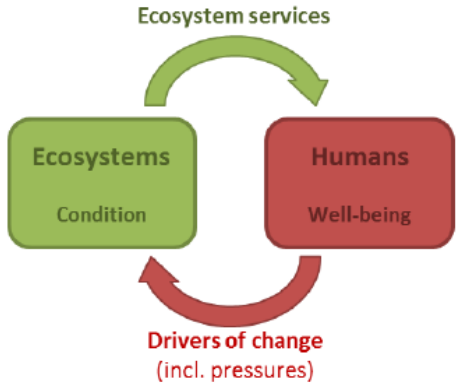

Fig. 10: Simplified MAES conceptual model used by pilot assessments to develop an indicator framework for ecosystem condition. The model suggests that there are links between pressures, condition and ecosystem services. Reducing pressures can positively affect ecosystem condition and create and maintain benefits for humans.[114]

Ecosystem condition is defined as the physical, chemical and biological condition or quality of an ecosystem at a particular point in time (definition used in MAES). The Millennium Ecosystem Assessment has defined ecosystem condition as the capacity of an ecosystem to deliver ecosystem services, relative to its potential capacity (MA 2005). The SEEA-EEA defines ecosystem condition as the overall quality of an ecosystem asset in terms of its characteristics.

It is worth mentioning that a significant criticism of the ecosystem services concept is whether protection of ecosystem services guarantees conservation of biodiversity. Some scholars argue that

111 European Commission. (April 2013). "Mapping and Assessment of Ecosystems and their Services An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020." Discussion paper.

112 Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment." Island Press. A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment.

113 European Environment Agency (EEA). (September 2015). Exploring Nature-based Solutions: The role of green infrastructure in mitigating the impacts of weather- and climate change- related natural hazards.

114 Source: Maes, J.et al. (2018) Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg.

relying on the ecosystem services approach to halting biodiversity decline is misguided, as the relationship between biodiversity and ecosystem services is not yet entirely clear.[115] In other words, it is questioned if the implementation of the ecosystem services approach also protects biodiversity. Moreover, the anthropocentric focus excludes the idea of ecosystems and biodiversity as inherently valuable, beyond human needs.

Decades of research have shown that biodiversity plays a vital role in ecosystem functioning. Processes such as capturing essential resources, producing biomass, and recycling nutrients are impaired as biodiversity declines. Furthermore, biodiversity underpins ecosystem functioning and enables these processes to be resilient in global change.[116]

Though **uncertainty remains regarding the links between biodiversity and ecosystem services,** there is mounting evidence that biodiversity is also vital for ecosystem services provision. Not all ecosystem services rely on biodiversity to the same degree. For example, regulating services often rely heavily on biodiversity, which can be vital in sustaining other ecosystem services. In contrast, provisioning services are less dependent on biodiversity. However, they require healthy soils and available nutrients.[117] For example, even for crop production, there is evidence to show that biodiversity is likely to be crucial for maintaining the stable provision of multiple ecosystem services in the long term and under global environmental change. Species richness and functional diversity are key attributes associated with increased resistance, stability, and resilience in ecosystem functions such as primary productivity and carbon sequestration.[118]

1.6. Key takeaways

- Biodiversity (a term that is a contraction of 'biological diversity') comprises the three fundamentally different levels of diversity:
  - Genetic diversity,
  - species diversity, and
  - ecosystem diversity.

  Most of policy and public debate on biodiversity protects specific species and habitats.
- As part of the IPBES methodology for the assessment of changes to the state of biodiversity, the IPBES explores the trends in the drivers of change, or pressures on biodiversity. According to the five main pressures on biodiversity:
  - Land/sea/ use change
  - Resource exploitation
  - Pollution (air, water, waste, noise, light)

[115] European Commission. (May 2015). "Science for Environmental Policy In-Depth Report: Ecosystem Services and Biodiversity."

[116] European Commission. (May 2015). "Science for Environmental Policy In-Depth Report: Ecosystem Services and Biodiversity."

[117] European Commission. (May 2015). "Science for Environmental Policy In-Depth Report: Ecosystem Services and Biodiversity."

[118] Constanza, 1997

  - Climate change
  - Introduction of invasive species
- Evidence indicates that global biodiversity decline occurs at rates higher than ever before and the risk exists that biodiversity loss undermines the climate change mitigation goals.
- 2021 and 2022 are landmark years for integrated climate change- biodiversity action for reaching the critical targets for 2030.
- Nature can provide up to 37% of mitigation needed to meet the goal of the Paris climate agreement, about one-third of the climate solution.
- Nature-based solutions are recognized for their potential to jointly addressing climate change and biodiversity loss.
- According to IPBES-IPCC joint report a top priority for integrated climate-biodiversity outcomes is the conservation of natural ecosystems, and, more important, carbon-rich ecosystems. According to IUCN NbS must result in a net gain to biodiversity and ecosystem integrity.
- There is connection between ecosystems' condition and the services they deliver. The decline of biodiversity leads to the decline of the capacity of ecosystems to provide ecosystem services that rely on biodiversity, thus affects the long-term people and businesses' dependencies on nature.
- A top priority from a joint climate change- biodiversity perspective is protecting and restoring carbon-rich ecosystems.
- According to IUCN NbS must "result in a net gain to biodiversity and ecosystem integrity."

2. LITERATURE REVIEW ON INVESTORS DEMAND FOR BIODIVERSITY

2.1. The 'E' in ESG-Criticism to the climate-only focus

Though it is a still- nascent ESG consideration for investors, the biodiversity crisis is climbing up the agenda. It is emerging as the next priority for many investors looking to build sustainability into their portfolios. On the one hand, there is evidence that global biodiversity decline occurs at unprecedented rates. On the other hand, there is scientific evidence that "without urgent action to halt and reverse biodiversity loss, reductions in greenhouse gas emissions to limit warming to close to 1.5°C or even 2°C will not be achieved."[119] Therefore, biodiversity loss can undermine climate change mitigation efforts, an already established priority for investors. Moreover, there is a narrow window of 10 years for solutions to the climate crisis and reversing biodiversity loss trends.

Biodiversity-related reporting is also a response to criticism that the 'E' of ESG has become **nearly synonymous with attempts to mitigate climate change.** However, climate change represents only one part of the environmental equation. Though biodiversity is interlinked with climate change, it has not been addressed yet to the required extent. It has been demonstrated that disclosure on biodiversity is currently far less prevalent than other environmental topics, most notably climate. Where disclosures on biodiversity were provided, they often lacked the relative specificity and maturity of climate-related disclosure and the use of metrics containing generic management approaches and high-level commitments.[120]

2.2. ESG Reporting current focus on Biodiversity

'E' in ESG should account for the financial risks associated with a company's dependence on natural resources, as well as the effect of its operations on the environment, both direct and across its supply chains.[121]

Biodiversity loss is a material risk for investors. Biodiversity is a fundamental component of long-term business sustainability since businesses rely on natural resources as inputs and depend on healthy ecosystems.[122] A 2020 research by Swiss-Re found that 55% of our global GDP depends on well-functioning ecosystems, **"moderately or highly dependent on nature and its service."** Therefore, the

[119] IPBES-IPCC Report, and also article Bridging COP26 and COP15: EU highlights the need to tackle the nature and climate crises together, 29 October 2021.https://ec.europa.eu/environment/news/bridging-cop26-and-cop15-2021-10-29_en

[120] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[121] Craig, D. Expanding the E in ESG. Article published in fDi Intelligence August/September 2021 print edition. https://content.yudu.com/web/43wcl/0A43wm9/fDiAugSept2021/html/index.html?origin=reader

[122] ESG Clarity. (September 2020). "Can ESG awakening end the biodiversity crisis?"

incentive for companies to contribute towards global solutions has never been greater.[123] The most significant dependencies and impacts for many companies are usually found in the supply chain.[124]

At the same time, organizations contribute to the drivers of biodiversity decline through their direct operations as well as upstream and downstream value chain activities, with impacts including:[125]

- Decline of ecosystem's extent and condition.
- Risk of species extinction.
- Changes to ecological communities (e.g., loss of naturally abundant species);
- Changes to biomass and species abundance.
- Deterioration of the elements of nature for indigenous peoples and communities.

Biodiversity impacts are interconnected to dependencies due to feedback loops, e.g., an organization's operations may depend on a particular species of fish (dependency), yet if the organization fishes at non-sustainable levels, the population of the species may reduce due to overfishing (impact) causing loss of operational productivity and related income and/or increased costs. Business biodiversity dependencies and impacts vary according to the sector, value chain, and geographic location. Both dependencies and impacts generate economic costs and benefits for businesses and society, resulting in risks and opportunities affecting the present and/or future enterprise value.[126] Degradation of nature poses a material risk to business operations. For the first time in 2020, the top five global risks identified by the World Economic Forum's Global Risks Report relate to the environment, with global biodiversity loss and climate ranking at the top.[127]

As already described as part of the 2020-21 research, ESG systems are a work-in-progress field. Many systems are subject to ongoing revision, testing, and refinement, driven by investors' demand. The ESG systems reflect investors' demand and mark a transition to global-level goals alignment. SDG investing is a broader investors' alignment focus with biodiversity and climate inherent components of this more overall demand for sustainable development. Therefore, the focus on biodiversity aligns with SDGs and supports reporting of SDG-aligned performance.

For the broader sustainable development agenda, it appears virtually impossible to achieve most of the UN Sustainable Development Goals (SDGs) without a far more robust effort to protect, connect and

123 GRI. (June 2021). Biodiversity crisis emphasizes need for corporate transparency." https://www.globalreporting.org/about-gri/news-center/biodiversity-crisis-emphasizes-need-for-corporate-transparency/

124 ESG Clarity. (June 2021). "Breaking down biodiversity: An investor's guide."

125 CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

126 CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

127 Barber, C.V., R. Petersen, V. Young, B. Mackey and C. Kormos. (2020). "The Nexus Report: Nature Based Solutions to the Biodiversity and Climate Crisis." F20 Foundations, Campaign for Nature and SEE Foundation.

restore natural ecosystems and the services and benefits they provide.[128] Addressing the decline of biodiversity and climate change are essential to achieving many SDGs; biodiversity and climate change underpin them.

Moreover, several of the targets of the Draft post-2020 Global Biodiversity Framework, as proposed by CBD, are specifically focused on the role to be played by businesses, including target 15 that requires that "all businesses (public and private, large, medium and small) **assess and report** on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, by at least half and increase positive impacts, reducing biodiversity-related risks to businesses and moving towards the full sustainability of extraction and production practices, sourcing and supply chains, and use and disposal."[129] It is worth mentioning that the Strategic Plan for 2010-2020 and its Aichi Targets did not request for biodiversity-related reporting, but rather the development of action plans for sustainable use of natural resources.[130] This highlights the current high focus of mainstreaming biodiversity.

There are key developments expected in 2022 that taken together suggest strong positive momentum behind nature next year. But progress across business and finance will still occur against the backdrop of continued nature loss – and a corresponding increase in nature-related financial risks.[131]

2.3. Challenges in Nature-related Financial Reporting; knowledge and data gap

With the growing awareness of the interlinkages between nature and climate companies will seek to translate these connections into their strategy, targets and metrics, risk management and disclosures.[132]

"A common comment is the challenge of measuring biodiversity. Compared to climate change, where greenhouse gas emissions are used as a universally agreed indicator, biodiversity is a local issue, and standardized indicators do not yet exist.[133]

In the case of climate change, the market has been increasingly able to provide meaningful metrics to demonstrate a company's exposure to risks. The TCFD has been instrumental in advancing corporate data on climate-related risks.

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128 Barber, C.V., R. Petersen, V. Young, B. Mackey and C. Kormos. (2020). "The Nexus Report: Nature Based Solutions to the Biodiversity and Climate Crisis." F20 Foundations, Campaign for Nature and SEE Foundation.

129 Convention on Biological Diversity (CBD). (July 2021). "First Draft of the Post-2020 Global Biodiversity Framework."

130 Aichi Target 4: Sustainable production and consumption
By 2020, at the latest, Governments, **business** and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

131 TNFD. (December 2021). "What to expect for nature-related business & finance in 2022."

132 TNFD. (December 2021). "What to expect for nature-related business & finance in 2022."

133 ESG Clarity. (September 2020). "Can ESG awakening end the biodiversity crisis?"

"When it comes to data, metrics, and methodologies, there are critical differences between climate and nature. Unlike climate, **it is not just your activities that matter but also where the activities are**. This means that collecting more location-specific data from corporations will be required."[134] Considering this complexity, it is difficult to select, e.g., a shortlist of useful and feasible indicators to monitor everywhere.

2.4. The formation of the Taskforce for Nature-related Financial Disclosures (TNFD)

Key evidence of the increased importance of mainstreaming biodiversity in corporate accounting is the recent formation of TNFD. The initiative to form a Taskforce on Nature-related Financial Disclosures (TNFD) was announced in July 2020. TNFD was formally launched and endorsed by the G7 Finance ministers and G20 Sustainable Finance Roadmap as the G20 and G7 Environment and Climate Ministers. TNFD's mission is "to develop and deliver a risk management and disclosure framework for organizations to report and act on evolving nature-related risks, which aims to support a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes."[135] Therefore, it has a similar mission to the Taskforce for Climate-related Financial Disclosures (TCFD).

According to TNFD, nature-related financial risks and opportunities are "all financial risks and opportunities to an organization as a result of impacts and/or dependencies on nature".[136]

TNFD faces the challenge of streamlining the data, metrics, and methodology for nature-related performance. "As TNFD kicks off its work to plan, test, and deliver framework, the challenge is to learn from what has worked for climate while carefully considering how nature requires a different approach. Ultimately TCFD and TNFD will complement each other and work in tandem."

PART 2: RESEARCH TOOLS

1. ESG SYSTEMS AND BIODIVERSITY-RELATED REPORTING

1.1. Overview of ESG systems under review

A more focused and targeted study of selected ESG reporting frameworks and standards will provide insight on key research questions:

- How is biodiversity risk accounted for in the different systems?
- Which biodiversity topics are considered relevant and material to investors?

[134] Craig, D. Expanding the E in ESG. Article published in fDi Intelligence August/September 2021 print edition. https://content.yudu.com/web/43wcl/0A43wm9/fDiAugSept2021/html/index.html?origin=reader

[135] https://tnfd.global/about/

[136] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."

Given that biodiversity-related reporting is currently under update or development, initial approaches will presented, along with systems biodiversity-related disclosures so far. The selection of systems was based on well-established frameworks and standards that are also referenced in the TNFD's published workplan as work already performed that the TNFD recommendations will draw from. It is worth mentioning the case of the SBTN commitment framework which is recommended as guidance by TNFD, and is not an ESG standard.

ESG frameworks and Standards studied as part of the research:

The approach of Taskforce for Nature-related Financial Reporting (TNFD) as outlined in its workplan and technical scope published in June 2021.

The Climate Disclosure Standards Board's (**CDSB**)[137] draft Application Guidance for Biodiversity-related disclosures. Released in September 2021, the biodiversity-related guidance is the third CDSB Framework supplementary document, part of its application guidance on the natural capital elements of climate change, water, and biodiversity.

The Science Based Targets Network's (SBTN) draft guidance on science-based targets for nature: Global Commons Alliance's SBTN released its initial guidance for business in September 2020 as a first step toward integrated SBTs for all aspects of nature: biodiversity, climate, freshwater, land, and ocean (expected in 2022). It is a voluntary commitment framework that calls businesses to set nature positive targets.

The Global Reporting Initiative (GRI) Biodiversity Standard. GRI set as a priority project the update of their 2016 Biodiversity Standard, which is planned to be released in the second half of 2022. The update aims "to represent internationally agreed best practice and align with recent developments and the relevant authoritative intergovernmental instruments in the field of biodiversity" and "to enable an organization to publicly disclose its most significant impacts on biodiversity and how it manages them."[138]
Moreover, it was announced that GRI and European Financial Reporting Advisory Group (EFRAG) have announced joining forces on the technical work for their respective new biodiversity standards.[139, 140] As there is no releases so far on GRI update's approach the Biodiversity Standard of 2016 will be reviewed to explore which biodiversity-related disclosures were included in its previous version.

[137] On January 2022 the CDSB has been consolidated into the IFRS Foundation to support the work of the newly established International Sustainability Standards Board (ISSB).

[138] https://www.globalreporting.org/media/2injjngv/gri-topic-standard-project-for-biodiversity-final-project-proposal.pdf

[139] GRI. (December 2021). EFRAG and GRI to co-construct biodiversity standard. https://www.globalreporting.org/about-gri/news-center/efrag-and-gri-to-co-construct-biodiversity-standard/

[140] EFRAG works for an EU biodiversity disclosure standard for the European Commission, as part of their work on European Sustainability Reporting Standards. A draft of the EU biodiversity disclosure standard is expected in mid-June.

The World Economic Forum's (WEF) and International Business Council (IBC) ESG Reporting Metrics and Disclosure Standards. The WEF IBC Standard is one of the most recent developments in ESG standards (2020) that aimed to provide a comprehensive standard for reporting integrating indicators from other existing tools and providing a more compact set of indicators.

The Sustainability Accounting Standards Board's (SASB) Accounting Standards. The SASB Standards developed in 2018 is a widely used industry-specific standard that focuses only on what it considers material topics per industry.

The GRESB Infrastructure Asset Assessment ESG benchmark and reporting framework. GRESB assesses ESG performance at the asset level for infrastructure and is the most infrastructure project-specific standard among the ones reviewed. The 2022 assessment pre-release will be reviewed to explore if and how biodiversity impact and risk are accounted for as part of infrastructure assets sustainability assessment.

As part of the review a selective overview of the systems' principles, approaches and indicators and metrics will be presented, focusing on elements that will guide the selection of key biodiversity performance criteria.

1.2. Current Approach of Selected Systems to Biodiversity

Though several existing ESG systems are in a process of updating their biodiversity-related disclosures, it is worth reviewing how they have addressed biodiversity so far.

Every system includes indicators that report on the changes to the state of biodiversity, extent and/or quality and indicators that report on the identified by IPBES pressures on biodiversity (or drivers of change) as seen in literature:

- Land/freshwater/sea change
- Resource exploitation
- Pollution (air, water, waste)
- Climate change
- Introduction of invasive species

Reporting is required for impact during operations and the entire supply chain where material.

The WEF-IBC Reporting Metrics and Disclosure Standards highlight 'nature loss' as an urgent emerging issue and recognize growth in demand of land as "the primary underlying driver of new conversions of ecosystems, which is in turn the primary driver of nature loss." This is why its indicators mainly focus on ecosystem extent change. The pressures on biodiversity are addressed through other environmental themes.

WEF-IBC requests Environmental Sustainability certification standards or formalized sustainable management programs as evidence. According to WEF-IBC they are "the primary ways to ensure that

any land which must be used for production is used in a way that maintains or improves its quality and minimizes any adverse production impacts."

Table 7: WEF IBC themes and related metrics and disclosures that refer to Biodiversity

	Themes	Metrics and disclosures		Focus of the indicator
WEF IBC	**Nature loss**	**Land use and ecological sensitivity (core metric)**	Report the number and area (in hectares) of sites owned, leased or managed in or adjacent to protected areas and/or key biodiversity areas (KBA). (source: GRI 304-1) Alongside this disclosure, companies may wish to share information on the measures in place to ensure effective stewardship of these sites.	**STATE OF BIODIVERSITY: ECOSYSTEMS (extent)**
		Land use and ecological sensitivity (expanded metric)	Report for operations (if applicable) and full supply chain (if material): 1. Area of land used for the production of basic plant, animal or mineral commodities (e.g. the area of land used for forestry, agriculture or mining activities). 2. Year-on-year change in the area of land used for the production of basic plant, animal or mineral commodities. Note: Supply-chain figures can initially be estimated where necessary based on the mass of each commodity used and the average mass produced per unit of land in different sourcing locations. 3. Percentage of land area in point 1 above or of total plant, animal and mineral commodity inputs by mass or cost, covered by a sustainability certification standard or formalized sustainable management program. Disclose the certification standards or description of sustainable management programs along with the percentage of total land area, mass or cost covered by each certification standard/program.	**STATE OF BIODIVERSITY ECOSYSTEMS: (extent) For OPERATIONS & SUPPLY CHAIN**
		Impact of land use and conversion (expanded metric)	Report wherever material along the value chain: the valued impact of use of land and conversion of ecosystems. (source: Natural Capital Protocol (2016)/ ISO 14008 Monetary valuation of environmental impacts and related environmental aspects (2019) / Value Balancing Alliance)[141]	**CHANGE IN THE STATE OF BIODIVERSITY: ECOSYSTEMS (extent) VALUE CHAIN**
	Risk and opportunity oversight	**Integrating risk and opportunity into business process**	Company risk factor and opportunity disclosures that clearly identify the principal material risks and opportunities facing the company specifically (as opposed to generic sector risks), the company appetite in respect of these risks, how these risks and opportunities have moved over time and the response to those changes. These opportunities and risks should integrate material economic, environmental and social issues, including climate change and data stewardship.	
		Economic, environmental and social topics in capital allocation framework	How the highest governance body considers economic, environmental and social issues when overseeing major capital allocation decisions, such as expenditures, acquisitions and divestments.	

[141] Reporting valued impact in monetary terms provides a meaningful indication of the scale of impacts in units that can be readily understood by executives and compared across impact areas and with financial figures. Valuation of environmental impacts is increasingly recognized as the most efficient and effective way of incorporating as much relevant contextual information as possible to provide estimates of actual impact, rather than simply measures of output as is the case with most quantitative environmental metrics.

Pressures on biodiversity are addressed through other indicators:

Table 8: WEF IBC themes and related metrics and disclosures that address pressures on biodiversity

	Themes	Metrics & disclosures	Pressures as defined by IPBES
WEF IBC	Climate change	Greenhouse gas (GHG) emissions	CLIMATE CHANGE
		Paris-aligned GHG emissions targets	
	Freshwater availability	Water consumption and withdrawal in water-stressed areas	RESOURCE EXPLOITATION
		Impact of freshwater consumption and withdrawal	
	Air pollution	Air pollution	POLLUTION (AIR)
		Impact of air pollution	
	Water pollution	Nutrients	POLLUTION (WATER)
		Impact of water pollution	
	Solid waste	Single-use plastics	POLLUTION (WASTE)
		Impact of solid waste disposal	
	Resource availability	Resource circularity	RESOURCE EXPLOITATION/ POLLUTION (WASTE)

The GRI Biodiversity standard incorporates reporting on pressures on biodiversity within its Biodiversity Standard's disclosures covering land use change, pollution and introduction of invasive species, pests and pathogens. These pressures along with climate change and resource exploitation are also addressed by disclosures in other environmental topics in operations and the supply chain as listed below.

Table 9: GRI Biodiversity Standard disclosures and other selected disclosures that refer to environmental impacts

	Topics	Disclosures	Reporting requirements	Focus of the indicator
GRI	Biodiversity	304-1 Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas	b. For each operational site owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas, the following information: i. Geographic location; ii. Subsurface and underground land that may be owned, leased, or managed by the organization; iii. Position in relation to the protected area (in the are adjacent to, or containing portions of the protected area) or the high biodiversity value area outside protected areas; iv. Type of operation (office, manufacturing or production, or extractive); v. Size of operational site in km2 (or another unit, if appropriate); vi. Biodiversity value characterized by the attribute of the protected area or area of high biodiversity value outside the protected area (terrestrial, freshwater, or maritime ecosystem); vii. Biodiversity value characterized by listing of protected status (such as IUCN Protected Area Management Categories, Ramsar Convention, national legislation).	STATE OF BIODIVERSITY: ECOSYSTEMS (extent and quality)
		304-2 Significant impacts of activities, products, and	a. Nature of significant direct and indirect impacts on biodiversity with reference to one or more of the following: i. Construction or use of manufacturing plants, mines, and transport infrastructure;	CHANGE IN THE STATE OF BIODIVERSITY: ECOSYSTEMS

		services on biodiversity	ii. Pollution (introduction of substances that do not naturally occur in the habitat from point and non-point sources); iii. Introduction of invasive species, pests, and pathogens; iv. Reduction of species; v. Habitat conversion; vi. Changes in ecological processes outside the natural range of variation (such as salinity or changes in groundwater level). b. Significant direct and indirect positive and negative impacts with reference to the following: i. Species affected; ii. Extent of areas impacted; iii. Duration of impacts; iv. Reversibility or irreversibility of the impacts.	**(extent and quality)- SPECIES**
		304-3 Habitats protected or restored	a. Size and location of all habitat areas protected or restored, and whether the success of the restoration measure was or is approved by independent external professionals. b. Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures. c. Status of each area based on its condition at the close of the reporting period. d. Standards, methodologies, and assumptions used.	**STATE OF BIODIVERSITY: ECOSYSTEMS (extent and quality)**
		304-4 IUCN Red List species and national conservation list species with habitats in areas affected by operations	a. Total number of IUCN Red List species and national conservation list species with habitats in areas affected by the operations of the organization, by level of extinction risk: i. Critically endangered ii. Endangered iii. Vulnerable iv. Near threatened v. Least concern	**CHANGE IN THE STATE OF BIODIVERSITY: SPECIES**
	Environmental Compliance	**307-1 Non-compliance with environmental laws and regulations**	a. Significant fines and non-monetary sanctions for non-compliance with environmental laws and/or regulations in terms of: i. total monetary value of significant fines; ii. total number of non-monetary sanctions; iii. cases brought through dispute resolution mechanisms. b. If the organization has not identified any non-compliance with environmental laws and/or regulations, a brief statement of this fact is sufficient.	**CHANGE IN THE STATE OF BIODIVERSITY: ECOSYSTEMS (quality)**
	Supplier Environmental Assessment	**308-1 New suppliers that were screened using environmental criteria**	a. Percentage of new suppliers that were screened using environmental criteria.	**SUPPLY CHAIN**
		308-2 Negative environmental impacts in the supply chain and actions taken	a. Number of suppliers assessed for environmental impacts. b. Number of suppliers identified as having significant actual and potential negative environmental impacts. c. Significant actual and potential negative environmental impacts identified in the supply chain. d. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which improvements were agreed upon as a result of assessment. e. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which relationships were terminated as a result of assessment, and why.	**SUPPLY CHAIN**

Other disclosures addressing pressures on biodiversity:

Table 10: GRI topics and related disclosures that address pressures on biodiversity

	Topics	Disclosures	Pressures as defined by IPBES
GRI	Materials	301-1 Materials used by weight or volume	RESOURCE EXPLOITATION/ POLLUTION (WASTE)
		301-2 Recycled input materials used	
		301-3 Reclaimed products and their packaging materials	
	Water and Effluents	303-1 Interactions with water as a shared resource	RESOURCE EXPLOITATION/ POLLUTION (WATER)
		303-2 Management of water discharge-related impacts	
		303-3 Water withdrawal	
		303-4 Water discharge	
		Water consumption	
	Emissions	305-1 Direct (Scope 1) GHG emissions	CLIMATE CHANGE
		305-2 Energy indirect (Scope 2) GHG emissions	
		305-3 Other indirect (Scope 3) GHG emissions	
		305-4 GHG emissions intensity	
		305-5 Reduction of GHG emissions	
		305-6 Emissions of ozone-depleting substances (ODS)	
		305-7 Nitrogen oxides (NOX), sulfur oxides (SOX), and other significant air emissions	POLLUTION (AIR)
	Waste	306-1 Waste generation and significant waste-related impacts	POLLUTION (WASTE)
		306-2 Management of significant waste-related impacts	
		306-3 Waste generated	
		306-4 Waste diverted from disposal	
		306-5 Waste directed to disposal	

SASB focuses on disclosures only in material topics per industry sector.

Table 11: SASB disclosure topics and related metrics that refer to biodiversity and environmental impacts

	General issue category	Disclosure topics	Accounting metrics	Focus of the indicator
SASB	Ecological Impacts[142]	Environmental impacts of project development	Number of incidents of non-compliance with environmental permits, standards, and regulations	CHANGE IN THE STATE OF BIODIVERSITY (ECOSYSTEM QUALITY)
			Discussion of processes to assess and manage environmental risks associated with project design, siting, and construction	STATE OF BIODIVERSITY: ECOSYSTEMS (extent)
			Number and duration of project delays related to ecological impacts	STATE OF BIODIVERSITY: ECOSYSTEMS (quality)
			Description of efforts in (solar energy system) project development to address community and ecological impacts	
		Biodiversity	Terrestrial acreage disturbed, percentage of impacted area	CHANGE IN THE STATE

[142] Ecological Impacts: The category addresses management of company's impacts on ecosystems and biodiversity through activities including, but not limited to, land use for exploration, natural resource extraction, and cultivation, as well as project development, construction, and siting. The impacts include, but not limited to, biodiversity loss, habitat destruction, and deforestation at all stages- planning, land acquisition, permitting, development, operations and site remediation. The category does not cover impacts of climate change on ecosystems and biodiversity.

		impacts	restored	**OF BIODIVERSITY: ECOSYSTEMS (extent and quality)**
			Percentage of engines in service that meet Tier 4 compliance for non-road diesel engine emissions	
		Land use & Ecological impacts	Number of (1)lots and (2) homes delivered on redevelopment sites (in Home builders)	**CHANGE IN THE STATE OF BIODIVERSITY: ECOSYSTEMS (extent and quality)**
			Total amount of monetary losses as a result of legal proceedings associated with environmental regulations	
	Product Design & Lifecycle Management	**Ecological Impacts of Project Development**	(for wind energy projects) Average A-weighted sound power level of wind turbines, by wind turbine class	**STATE OF BIODIVERSITY: SPECIES - ECOSYSTEMS (quality)**
			(for wind energy projects) Backlog cancellations associated with community or ecological impacts	
			(for wind energy projects) Description of efforts to address ecological and community impacts of wind energy production through turbine design	
	Supply Chain Management	**Supply Chain Management**	Discussion of strategy to manage environmental and social risks arising from the supply chain	**SUPPLY CHAIN**
		Environmental & Social Impacts of supply chain	Percentage of [materials] sourced that are certified to a third-party environmental and/or social standard, and percentages by standard	**SUPPLY CHAIN**
			Suppliers' social and environmental responsibility audit (1) non-conformance rate and (2) associated corrective action rate for (a) major and (b) minor conformances	
			Discussion of strategy to manage environmental and social risks arising from contract growing and commodity sourcing	

Pressures on biodiversity are addressed through other indicators:

Table 12: SASB disclosure topics that address pressures on biodiversity

	General issue category	Disclosure topics	Pressures as defined by IPBES
SASB	**Materials Sourcing & Efficiency**	**Water Supply Resilience**	**RESOURCE EXPLOITATION**
		Material Sourcing	
	GHG Emissions	**Greenhouse emissions**	**CLIMATE CHANGE**
		Emissions Reduction Services & Fuels management	
		Fleet fuel management	
	Air quality	**Air quality**	**POLLUTION (AIR)**
	Water & Wastewater Management	**Water Management**	**RESOURCE EXPLOITATION**
		Effluent Quality Management	**POLLUTION (WATER)**
	Waste & Hazardous Materials Management	**Waste management**	**POLLUTION (WASTE)**
		Coal ash management	
		Management of Leachate & Hazardous Waste	
		Hazardous Waste Management	

Finally, the GRESB infrastructure asset assessment apart from covering the key pressures on biodiversity, introduces the 'habitat net gain' metric. This metric is based on the mitigation hierarchy, a well-established biodiversity impact management approach at the project level. The mitigation hierarchy is a precautionary four-step approach to mitigate the direct, attributable biodiversity impacts of a development project. Given its importance and its direct connection with nature positive goals the mitigation hierarchy will be further analyzed in a following paragraph.

Table 13: GRESB performance indicators and metrics that refer to biodiversity

	Aspects	Performance Indicators	Metrics	Focus of the indicator
GRESB	**Biodiversity & habitat**[143]	**Biodiversity & habitat**	Wildlife fatalities	**STATE OF BIODIVERSITY: SPECIES**
			Threatened & Endangered **(**T&E)[144] species fatalities	
			Habitat removed	**CHANGE IN THE STATE OF BIODIVERSITY: ECOSYSTEMS (extent and quality)**
			Habitat enhanced or restored	
			Habitat protected (on-site)	
			Habitat protected (off-site)	
			Net habitat gain = "Habitat enhanced or restored" + "Habitat protected (on-site)" + "Habitat protected (off-site)" - "Habitat removed"	
			Habitat maintained	
			Habitat gain intensity (per GAV; per revenue/ per output)	
	GRESB requests evidence that the reported data has been subject of external review of by an independent third party and lists a series of schemes.			

Pressures on biodiversity are addressed through other indicators

Table 14: GRESB performance indicators that address pressures on biodiversity

	Aspects	Performance Indicators			Pressures as defined by IPBES
GRESB	**Greenhouse gas emissions**	**Greenhouse gas emissions**	Scope 1 emissions	Emissions form combustion of fuels	**CLIMATE CHANGE**
				Process emissions	
				Fugitive emissions	
			Scope 1+2 emissions		
			Scope 1+2+3 emissions		
			On-site offsets		
			Offsets purchased		
			Net GHG emissions (scope 1+2)		
			Net GHG emissions (scope 1+2+3)		
			Emissions avoided (export of renewable energy)		
		Scope 3 GHG emissions			
		Scope 2 GHG emissions			
		Science-based targets			
	Air pollution	**Air pollution**			**POLLUTION (AIR)**
	Water	**Water inflows/ withdrawals**			**RESOURCE EXPLOITATION**
		Water outflows/ discharges			**POLLUTION (WATER)**

[143] 2021 Asset Assessment, same in the 2022 Asset Assessment Prelease

[144] Animal and plant species that are either on the IUCN Red list, or have been designated as threatened, endangered, or protected, by local or national governments.

	Waste	**Waste generated and disposed**	**POLLUTION (WASTE)**

Moreover, biodiversity and pressures on biodiversity are among a set of environmental issues that GRESB has identified as critical and potentially material to infrastructure assets:

- Air pollution
- **Biodiversity and habitat**[145]
- Contaminated land
- Energy
- Greenhouse gas emissions
- Hazardous substances
- Light pollution
- Material sourcing and resource efficiency
- Noise pollution
- Physical risk
- Waste
- Water outflows/discharges
- Water inflows/withdrawals

GRESB requests infrastructure owners/ or asset managers to report:

- Policies that cover those environmental issues that are material to each asset
- Environment risk assessment
- Monitoring of environmental performance against those environmental issues
- Materiality assessment

Finally, the GRESB materiality assessment indicates when biodiversity-related issues are material to an asset and materiality is defined by both the impacts of an asset on biodiversity and its dependencies on biodiversity:

Table 15: Biodiversity- related issues included in GRESB Materiality assessment

Potential Material Issues	Impact or Dependency
Habitat and biodiversity - What is the entity's proximity to ecological habitat? • Containing, overlapping, adjacent • Close (<100m) • Distant (>100m)	**impact/ risk**
Contaminated land - Does the entity have contamination on site? • Yes • No	**impact/ risk**
Physical risk (climate-driven and otherwise) - Is the entity located in an area exposed to climate-related phenomena or natural catastrophes? • Yes • The entity is exposed	**Impact/ risk** however not climate-driven risk on biodiversity is included

[145] According to GRESB, biodiversity and habitat refers to 'issues related to wildlife, endangered species, ecosystem services, habitat management, and invasive species. Biodiversity refers to the variety of all plant and animal species. Habitat refers to the natural environment in which these plant and animal species live and function.

• Only the surrounding area is exposed • No	
Water inflows/withdrawals - What is the scale of the entity's water use/withdrawal and water stress in the location? • High (>1000 Megaliters) water withdrawals in locations with high water stress • High (>1000 Megaliters) water withdrawals in locations with low water stress • Low (<1000 Megaliters) water withdrawals in locations with high water stress • Low (<1000 Megaliters) water withdrawals in locations with low water stress • No withdrawals	**dependency**
[impact] Water outflows/discharges - Is there a risk of pollution from discharges to waterways (including groundwater)? • Yes and waterways are in locations with high water stress • Yes but waterways are not in locations with high water stress • No	**impact**
Light pollution – Does the entity use significant external lighting at night? • Yes and the location is densely populated • Yes but the location is not densely populated • No	**Impact** – though light pollution has impact on biodiversity GRESB focuses only on impact to the community.
Noise pollution – Does the entity emit noise externally? • Yes and the location is densely populated • Yes but the location is not densely populated • No	**Impact** – though noise pollution has impact on biodiversity GRESB focuses only on impact to the community.

1.3. ESG Systems Updated Approach to Biodiversity

1.3.1. Taskforce for Nature-Related Financial Reporting (TNFD)

As set out in the TNFD's proposed technical scope, the TNFD framework **will broadly seek to align with the two proposed global targets in the draft Global Biodiversity Framework of no net nature loss by 2030 and net gain by 2050**.[146]

The TNFD framework will build upon the same structure as TCFD, the four-pillar approach, with the view to enabling companies to assess climate- and nature-related risks and opportunities together wherever possible[147]:

- Governance
- Strategy
- Risk Management
- Metrics and targets

Nature-related risks and opportunities refer collectively to positive or negative impacts on nature, dependencies on nature, and financial risks and opportunities resulting from these impacts and dependencies[148].

[146] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."
[147] TNFD. (December 2021). "What to expect for nature-related business & finance in 2022."
[148] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."

The TNFD Scope is focused on:

- Living (biotic) nature covering habitats, species and genetic resources, from all sources including terrestrial, marine and other aquatic ecosystems.
- An organization's impacts on water, air and soil
- Mineral depletion as it relates to other aspects of nature

Risks are related to an organization's impacts and dependencies on nature. In addition to shorter-term financial risks, the scope includes longer term risks represented by its impact and dependencies on nature. Moreover, it is worth adding that TNFD aims to "prioritize types of nature impacts that are associated with 'tipping points' after which ecosystems may collapse (no longer function properly) beyond the point of repair."[149]

The TNFD identifies two types of nature-related financial risks and opportunities:

- Nature-related physical risks and opportunities: Physical risks resulting from nature loss can be categorized as event driven (acute), or longer-term shifts (chronic) in the way in which natural ecosystems function – or cease to function.
- Nature-related transition risks and opportunities: the extensive policy, legal, technology, and market changes entailed in transitioning to a nature-positive economy, including reputation, compliance, and liability or litigation risks. For example, commitment to international frameworks goals, such as the CBD's Post-2020 Global Biodiversity Framework, will define the changes that may need to be made and hence, the drivers of transition risk.

Parallels can be drawn to the categorization of climate-related risks by the TCFD as physical and transition risks.

In terms of its recommendations on biodiversity-related disclosures, the TNFD framework will align with and draw from existing initiatives, frameworks and standards relevant to its scope, such as GRI, SASB, and CDSB. The TNFD does not intend to develop a standard (either for disclosure or broader activities) itself, but rather act as an aggregator of the best tools and materials to promote worldwide consistency for nature-related reporting, while avoiding duplication of work. The TNFD intends for its outputs to be integrated into existing frameworks and standards. "The TNFD intends for reporting entities to integrate TNFD-aligned reporting within mainstream corporate reporting, as opposed to the creation of a dedicated 'TNFD report'."

Moreover, as TNFD-aligned reporting material it suggests use of data not only from corporate disclosure tools but also data and metrics from frameworks such as the UN SEEA and the UN CBD Post-2020 Global Biodiversity Framework.

TNFD's scope aims to include "**how reporting should tackle interactions between climate and nature" and adequately account for "the synergies between solutions to the nature and climate crises" and capture the dual climate and nature benefits of NbS to climate change, as well as the dual climate and**

[149] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."

nature risks posed by the degradation of natural carbon sinks.[150] TNFD will provide guidance on how organizations report their response to climate-nature interactions.

This will require an explicit consideration of the interaction between nature and climate-related risks and opportunities and an understanding of the degree to which current climate and land use risk management and strategy address nature crisis. Also implies the joint consideration of future nature and climate policy pathways in scenario analysis.

The TNFD collaborates with the TCFD in order to identify how best to operationalize these interactions and how the TNFD-aligned reporting can best interact with TCFD-aligned reporting.

The TNFD recognizes that "that accounting for the impacts of climate change on nature loss and the impacts of nature loss on climate change represents an additional layer of complexity within reporting." This is why TNFD recommends that reporting requirements should be staged with progressive levels of sophistication:

- Basic: Simple adjustments for nature-based solutions and natural carbon sinks
- Intermediary: Simple adjustments for interactions and transition pathways
- Comprehensive: Comprehensive adjustments for interactions and joint scenario analysis

1.3.2. CDSB: A framework for climate change, environmental and natural capital-related reporting

The CDSB Framework has evolved over time and since its first version released in 2010 and focused on the climate change risks and opportunities for businesses. In 2013, the scope of the Framework was expanded beyond climate change and GHG emissions to encompass environmental information and natural capital, with this revision published in 2015. The CDSB[151] Framework is one of the first ESG systems to deliver draft guidance focused on biodiversity-related impacts, risks and opportunities, in September 2021.[152]

As stated by CDSB **"the Biodiversity guidance aims to expand the TCFD recommendations to nature".** It is worth noting that the CDSB Framework represented one of the main resources from which the recommendations of the Task Force on Climate-related Disclosure (TCFD) were drawn and is participating in the think tanks and consortia behind the development of the TNFD recommendations. Therefore, it can be argued that CDSB provides a potential preview of TNFD recommendations for nature-related financial disclosures.

[150] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."pg.24.

[151] On 31st January 2022, the Climate Disclosure Standards Board (CDSB) was consolidated into the IFRS Foundation to support the work of the newly established International Sustainability Standards Board (ISSB).

[152] Since June 2019 CDSB is working on a four-year EU-funded LIFE FinACTION project "Enhancing nature-related financial disclosures in mainstream reports across Europe and beyond" to support report preparers in creating a paradigm shift across Europe and globally in the quality and quantity of decision-useful information to investors on four core elements of natural capital: air (including climate change, water, land, biodiversity (including drivers of deforestation).

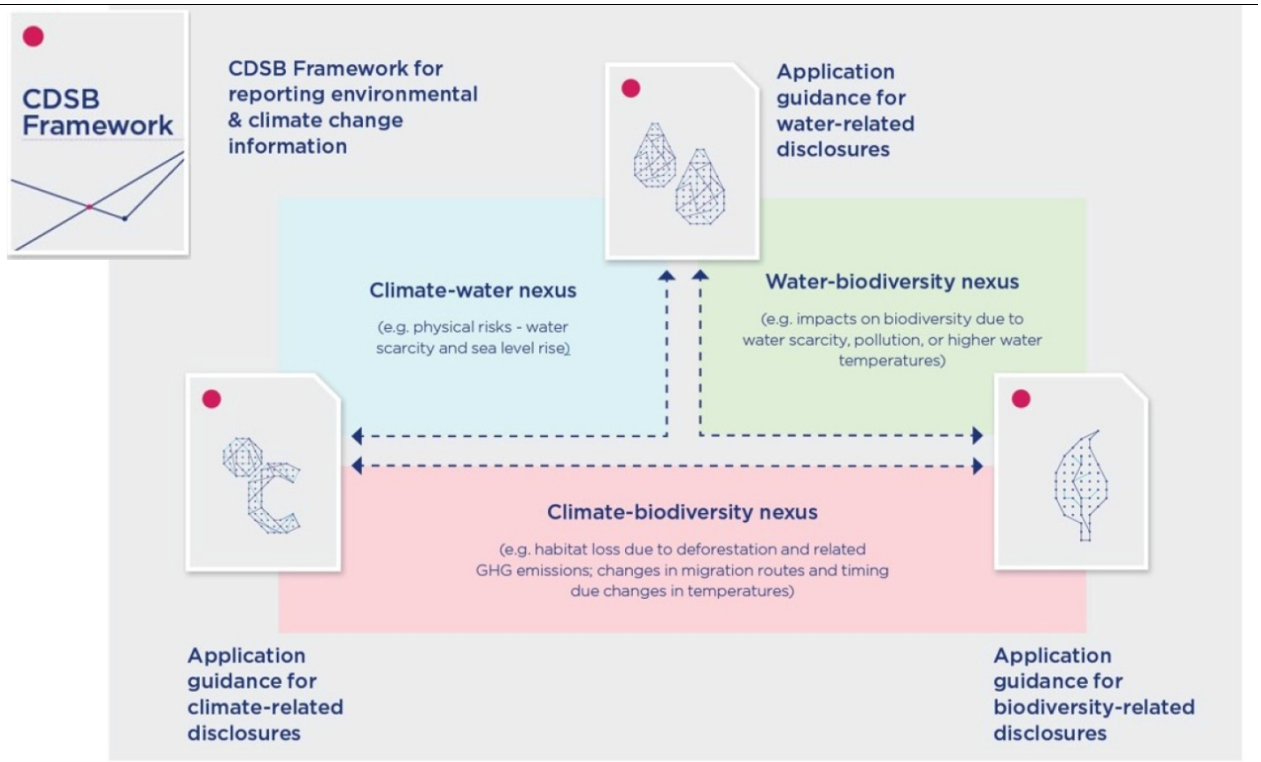

Fig. 11: Overview of the set of CDSB Framework supplementary guidance and their interconnections:

- **The climate – water nexus**
- **The water – biodiversity nexus**
- **The climate – biodiversity nexus**

Following the guidance on climate-related and water-related disclosures, the Biodiversity Guidance is the third CDSB Framework supplementary application guidance document that is designed to enhance the quality of disclosures for such material matters. Given the interconnected nature of environmental topics, the Application Guidance documents are complementary with some **overlapping sub-topics.**

Focus of the Biodiversity guidance is on the first six reporting requirements of the CDSB Framework:

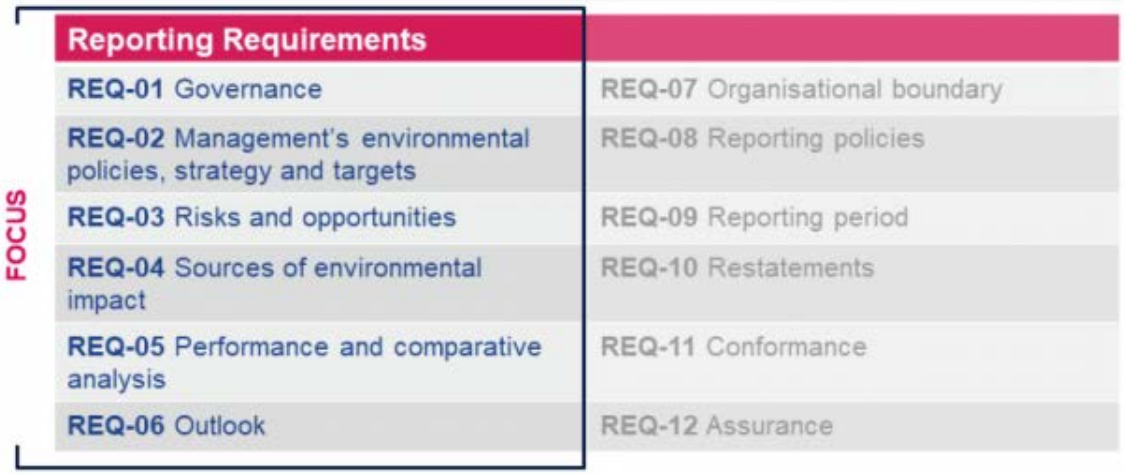

Fig. 12: The six reporting requirements of the total 12 requirements that form the CDSB Framework that the Draft Guidance on Biodiversity focuses on.

As part of Requirement 02 on company's environmental policies, strategy and targets the CDSB requests reporting of:

- Assessment of the company's biodiversity impacts and dependencies (both on-site and off-site dependencies, thus covering the entire value chain, if material). CDSB recommends that biodiversity impacts and dependencies are categorized into value chain phases, e.g. operations, upstream and downstream, and into different impact driver categories.
- Interaction between impacts and dependencies (e.g. a dependency that may result to overexploitation of resource and loss of species)
- Priority species, ecosystems and geographical areas for the company
- Policies and strategies. CDSB recommends that "strategies and policies are developed in connection to important agreements, policies or targets such as the SDGs, Science-based Targets for Nature and United Nations (UN) CBD post-2020 biodiversity framework or national and regional regulations and goals, e.g. EU Biodiversity Strategy for 2030, the Leaders Pledge for Nature, the Nature Compact signed by G7 leaders, National Biodiversity Strategy and Action Plans (NBSAPs), or sectoral initiatives, such as One Planet Business for Biodiversity which focuses on agriculture and the Finance for Biodiversity pledge."[153]
- Management responses. As guidance CDSB provides a list of potential management responses and highlights the mitigation and the conservation hierarchy principles as "useful for shaping management responses, management strategies and target setting, including along the value chain". It further comments that "Biodiversity net gain" or "no net loss" commitments and policies, involving mitigation hierarchy principles, are increasingly required by investors. **The conservation hierarchy**[154], which is designed to be used alongside the mitigation hierarchy, provides a mechanism for delivering additional conservation potential beyond direct impact mitigation. Given its importance and its direct connection with nature positive goals the additions of the conservation hierarchy to the mitigation hierarchy will be further analyzed in a following paragraph.

As part of Requirement 03 (REQ-03) CDSB provides definitions and examples of nature-related risks and opportunities and their financial implications, similarly to TCFD Recommendations defined climate-related risks and opportunities and impacts. CDSB follows TCFD's categorization of risks and opportunities into:

- Physical (acute and chronic)
- Policy and legal
- Market
- Technology
- Reputational risks

CDSB further links each type of risk with its source:

[153] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[154] https://conservationhierarchy.org/what-is-conservation-hierarchy/

- Climate change
- Water changes
- Land use changes
- Business-specific
- External context and drivers
- Changes to biodiversity/ ecosystems
- Loss of final ecosystem services (FES)

Table 16: Impacts and dependencies on biodiversity and associated financial risks

Sources of biodiversity-related business risks		linked to climate change	linked to water changes	linked to land -use	business-specific	caused by external context &drivers	related to changes to biodiversity/ ecosystems	related to loss of final ecosystem services	**Financial risks for the business**
Physical risks	**Acute**								• Increased natural hazard costs, e.g. impaired assets due to damages resulting from floods or cyclones (not limited to the organization's property e.g. infrastructures it relies on) • Reduced revenue and/or increased costs due to interruption of operations or interruption/ deterioration of supply chain as a consequence of uncertainty of natural inputs/raw material supply (e.g. loss of pollinators, pests, loss of fish stocks, water), or damages caused by natural hazard • Increased insurance premiums and potential for reduced availability of insurance on assets • Increased capital expenditure due to adaption to future climate and environmental scenarios (e.g. mechanical pollination, protection against floods) • Reduced productivity and consequent rethinking of production processes or timing • Write-offs, early retirement of existing assets and relocation of operations and suppliers, affecting the costs of raw materials (e.g. transportation)
	Degradation of biodiversity and ecosystems and loss of their natural protection, which exacerbates severity of damages of extreme weather events such as cyclones, droughts and flooding, storms	**C**	W	L	B	E	BD	FES	
	Leaks or accidental discharges contaminating air, soil and water bodies by the organization itself or by other stakeholders located in the same area causing degradation/loss of ecosystems		W	L	B	E	BD		
	Chronic								
	Increasing scarcity or variable production of key natural inputs	C	W	L	B	E		FES	
	Ecosystem degradation due to operations leading to, e.g. coastal erosion and forest fragmentation	C	W	L	B	E	BD		
	Ocean acidification (due to industrial waste or improper land management) causing degradation of reef, coastal and planktonic ecosystems and consequent losses of aquatic biodiversity	C	W			E	BD		
	Overfishing				B	E		FES	
	Land loss to desertification and soil degradation and consequent loss of soil fertility	C		L	B	E	BD	FES	
	Species loss and ecosystem degradation due to contamination of air, soil and water bodies (e.g. pesticides) caused by the organization itself or by other stakeholders located in the same area (also cumulative)		W	L	B	E	BD		

Policy and Legal	Changes to legislation, new regulations (e.g. creation of new protected areas) or license fees	C	W	L		E	BD		• Increased costs of operations and inputs to operations (e.g. higher charges for extracting ground water, timber or for waste disposal) • Increased costs of personnel (report preparers, biodiversity experts) and monitoring activities (e.g. data collection campaigns) required for reporting activities • Increased fines, penalties, compensation, or legal costs (e.g. for natural capital impacts) • Increased capital costs or production losses due to permit denials or delays • Reduced revenue from decreased production capacity due to limited access to natural resources • Fines due to violation of regulations • Increased costs and/or reduced demand for products and services resulting from fines and judgments • Loss of revenues or stranded assets due to loss of a permit to operate from litigation and/or from direct action by the regulator towards noncompliance • Increased compliance costs • Disruption of operations or supply of natural resources caused by poor trans-boundary governance or poor infrastructures • Loss of license to operate due to noncompliance • Increased loan interest payments • Increased export costs
	Tighter (emerging) regulation (e.g. taxes) on activities, products and/or services that impacts biodiversity (both species and ecosystems), ecosystems, and rights, permits, and allocations on natural resources designated to alleviate pressure on nature or impacts on local communities (e.g. their access to water, foraging, and hunting)	C	W	L		E	BD	FES	
	Enhanced reporting obligations on biodiversity, ecosystems and related services					E	BD	FES	
	Exposure to sanctions and litigation (e.g. spills of polluting effluents that damage human and ecosystem health; or violation of biodiversity-related rights, permits or allocations)				B	E	BD	FES	
	Non-compliance with legislation on, e.g. use of natural resources/ecosystems				B		BD	FES	
	Ineffective external biodiversity governance					E	BD		
	Lack of/or weak transboundary governance and cooperation resulting in biodiversity loss and nature degradation (e.g. biodiversity-rich ecosystems crossing national boundaries)					E	BD		
	Stakeholder conflicts due competition in the exploitation of resources and ecosystems or due to impacts on biodiversity or ecosystems caused			L		E	BD	FES	
Market	Shifting customer values or preferences to products with lower impacts on biodiversity and ecosystems (e.g. lower biodiversity footprint)					E	BD		• Reduced demand for products and services (reduced market share) • Increased production costs • Supply disruption • Increased raw material or resource costs • Loss of market access • Smaller customer base
	Volatility or increased costs of raw materials (e.g. biodiversity-intense inputs, for which price has raised due to ecosystem degradation)	C	W	L	B	E	BD	FES	
Technology	Transition to more efficient and cleaner technologies (i.e. with lower impacts on biodiversity and ecosystems)	C	W	L	B		BD		• Expenditure for R&D of new and alternative technologies • Capital investments in technology development • Unsuccessful investments in technology • Increased costs of operations and raw materials (e.g. higher energy use) required to achieve biodiversity-related goals (lack of integrated environmental assessment)
	Substitution to existing products and services with lower biodiversity footprint or cleaner emissions options	C	W	L	B		BD		
	Lack of access to data or access to poor quality data that hamper biodiversity-related assessment				B	E	BD		
	New monitoring technologies (e.g. satellite) used by regulators					E	BD		
	Adaptation technologies required to cope with new future scenarios and trends (e.g. climate resistant crops, mechanical pollinators, water purification, flood protection)	C	W	L	B	E		FES	
Reputational	Shifts in consumer sentiment toward the organisation/brand as a result/lack of biodiversity management and stewardship activities				B	E	BD		• Reduced demand and purchase of products and services • Workers' strike (in case of damages to natural resources, ecosystems and their

	Stigmatisation of sector due to impacts on biodiversity and ecosystems (e.g. mining, infrastructures)				B	E	BD		functioning used by local communities) • Loss of license to operate (e.g. after community protests)
	Stakeholders' (e.g . communities, activists, stockholders) perceptions, concerns and pressure related to the organisation's impacts on and management of biodiversity (e.g. toxic emissions; destruction of habitat of charismatic species, which have cultural, ethical, and/or philosophical values for societies; degradation of water, hunting and other resources for communities)				B	E	BD	FES	• Social license to operate, which may also result in stranded assets • Increased security costs • Increased staff turnover, higher recruitment and retention costs • Reduced loyalty of key suppliers or business service providers
	Violation of nature-related rights through operations (e.g. reduced access to timber for local communities; degradation of biodiversity-rich sites that have cultural value for local communities)	C	W	L	B		BD	FES	
	Negative media coverage due to impacts on critical species and/or ecosystems				B	E	BD		
	Biodiversity social conflicts over endangered species, protected areas, resources or pollution	C	W	L	B	E	BD	FES	

As part of Requirement 04 the sources of environmental impacts are reported. CDSB recommends indicators and metrics for:

- Biodiversity impact drivers
- Changes to the state of biodiversity. The Guidance considers terrestrial and aquatic biodiversity at the species and ecosystem levels, as well as the ecosystem services underpinned by biodiversity.[155]
- Valuation of impacts

[155] CDSB's ambitious push towards climate & nature-related financial reporting wins support from EU LIFE Programme

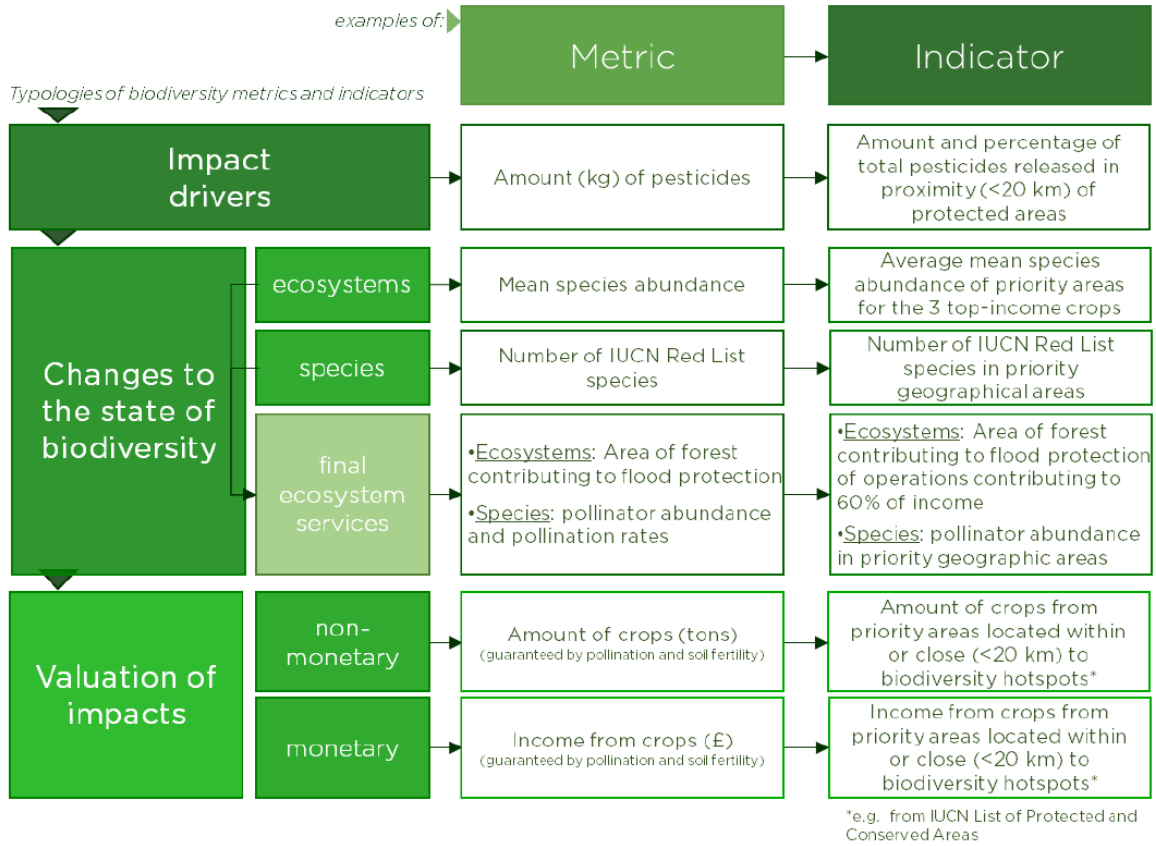

Fig. 13: Biodiversity metrics and indicators (source: CDSB Framework. (2021) Application guidance for biodiversity-related disclosures: draft application guidance for consultation).

Table 17: Examples of metrics outlining sources of biodiversity impacts[156]

Impact Driver	Description	Change in state of biodiversity	Examples metrics
Land, water and sea use change	Changes to land/sea/freshwater areas such as deforestation, urbanization, converting natural habitats for agriculture or seabed destruction (e.g. due to bottom trawling or marine construction) transforms the amount of natural habitat available and can cause habitat fragmentation.	Loss of habitat cover and connectivity, degradation and fragmentation can lead to changes to species distribution, changes to population sizes and loss of ecosystem function.	• **Area (Ha) of forest, grassland or wetland converted due urbanization** • Area (Ha) of degraded land converted to agricultural land • **Area (Ha) of land converted to monoculture** • Area (Ha) of mangrove protected and/or restored • Area (Ha) of marine area for aquaculture
Resource exploitation	Direct exploitation of organisms and natural resources, e.g. use of timber, use of water, exploitation of animals on or close to farms.	Decrease in abundance and diversity of species, genetic drift and habitat degradation.	Quantity (tons) of natural resources (e.g. leather, soy, palm oil) sourced per year Amount (tons) of fish caught Number of wild species exploited for commercial purposes **Volume of timber and non-timber forest products harvested**

[156] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation. Also, Resource exploitation (water), water pollution and air emissions indicators have been extracted from the CDSB Application guidance for water-related and climate –related disclosures.

			Total volumes of water withdrawals, consumption and discharges
			Volumes of water reused, recycled, produced or injected (e.g. in oil production), related efficiency metrics (e.g. % on total withdrawals) and related reduction in withdrawals or consumption
Light and noise pollution	Noise or light pollution as a result of operational activities, e.g. construction noise, artificial light emissions.	Changes to species behavior and distribution, including migration and breeding patterns (e.g. disruption of foraging, breeding or social behavior).	Decibels of noise above normal level
Waste	Plastic waste or waste assimilation.	Impacts on species abundance (e.g. reduction in abundance due to macroplastics or microplastics along food chain).	Amount (tons) of hazardous waste discharged
			Amount (tons) of non-hazardous waste incinerated
Soil pollution	Toxic pollution resulting from the use of agrochemicals being up taken by plant species and ingested across the food chain. Excessive nutrients used in agriculture entering water networks.	Loss of abundance or diversity of species that ingest of toxic pollutants (e.g. invertebrates, insects) and those that feed on them (e.g. birds). Aquatic eutrophication resulting in destruction of equilibrium in aquatic ecosystems.	Amount (kg) of pesticide discharged to soil
			Amount (kg) of fertilizers (and main components, e.g. nitrogen and phosphorous) applied to soil
Water pollution	Water pollutants resulting in reduced oxygen levels within the impacted waterway (e.g. river, lake, or stream) due to the input of chemicals.	Reduction in number of species present in affected area, including both those affected by chemicals and those that feed on them.	Concentrations of key pollutants in the wastewater
			Amount of arsenic released to surface water
			Amount of deleterious chemicals released to surface water
			Eutrophication potential (due to excess of nutrients e.g. due to use of fertilizers)
			Number of non-compliance incidents (due to violations of quantity permits, standards and regulations) that result in formal enforcement actions
			Unauthorized or non-compliant discharges
			Water-related ecosystem services and biodiversity metrics
Air Emissions	Emissions of GHGs and other air pollutants.	Decrease in air quality and climate change resulting in loss of ecosystem quality and changes to species distribution and population sizes.	Volume of CO2, sulphur dioxide (SO2), nitrogen oxide (NOx) and methane (CH4) emissions
			Scope 1 and 2 GHG emissions
			Scope 3 GHG emissions
			Land use, land use change and forestry (LULUCF) addition and withdrawal of GHGs

CDSB recommends disclosing a combination of biodiversity impact metrics that provide different perspectives (e.g. species abundance, species richness, habitat availability, ecosystem integrity, final ecosystem services) dependent on which are most relevant to the organization's specific biodiversity impacts.

Table 18: Changes to the state of biodiversity Metrics

Category of metrics		Example metrics
Ecosystem metrics	Key ecosystem metrics are based on the extent (assessed and monitored via satellite imagery or on-site) and the condition/ integrity of ecosystems	Quality ratings of ecosystems located in priority areas, which express the related condition/integrity and/or intactness of impacted ecosystem types, such as GLOBIO's Mean Species Abundance
		Potentially disappeared (PDF) or affected (PAF) fraction of species;
		Number or percentage of sites in which the ecological richness is progressing /stable/ regressing;
		Ecosystem/habitat cover change, e.g. forest area as a percentage of total land area or tree cover loss(ha)
		Ecosystem/Habitat fragmentation change (ha).
Species metrics	Risk of species extinction (e.g. through the STAR metric);	
	Areas (ha) of critical habitat for species in priority geographical areas;	
	Number of IUCN Red List species and national conservation list species within priority geographical areas;	
	Number of invasive alien species identified on the organizations' sites/impact areas;	
	Target taxa population sizes/abundance compared to actual population sizes; and	
	Measurements of species populations and habitat diversity from on-the-ground studies	
Final ecosystem services metrics	**Supply of final ecosystem services available to the business**	Amount of biomass available for fodder (tons)
		Amount of carbon absorbed by vegetation (tons)
		Pollinator abundance and pollination rates
		Amount of area that is suitable for nature-based tourism (ha)
	Delivery of final ecosystem services utilized by the business	Total production of all commercial crops (tons)
		Caloric content of fish landings (kcal)
		Volume of timber harvested (tons)
		Marginal contribution of soils to crop production,
		Area of avoided flood damage due to regulation by vegetation and soils (ha)
		Nature-based tourism visitation rates (no. of visits)
	Contributions to wellbeing to both internal and external stakeholders	Number of jobs contributed by aquaculture
		Basic needs satisfied via ecosystem service (e.g. number of people with access to adequate water)
		Number of people protected from flooding and erosion due to coastal protection
		Marginal contribution of pest control to food or biofuel production
		Marginal contributions to income or wellbeing of visitors

Metrics on habitat are a hybrid category between ecosystem and species metrics, because they refer to an area that is suitable for a species or a group of species, and, depending on the focus, they can be classified as an ecosystem or a species metric.

Finally, CDSB recommends the use of reporting metrics that value the impact of changes in biodiversity to the organization (i.e. the related costs and benefits). Valuation metrics may be quantitative,

qualitative, monetary or a –combination. Could be e.g. societal value or economic value, represent subjective perceptions, ranking impacts etc. Valuation relates to importance, worth, or usefulness of the impact and/or dependency, often considering context and impacted stakeholders.

As part of requirement 05 the performance against targets is requested.

Table 19: Example metrics for reporting progress against targets

	Example metrics
Reporting on progress against targets	Percentage increase in the area, connectivity and integrity of natural ecosystems within the organization's impact area
	Percentage increase in the population of threatened species within the organization's impact area;
	Non-compliance to biodiversity-related regulation (e.g. percentage of facilities with violations);
	Membership of biodiversity initiatives (e.g. percentage of facilities or suppliers with biodiversity-related certifications or number of partnerships signed with a biodiversity-related scientific body, NGO, foundation or nature conservation stakeholder);
	Number of farms applying approved techniques;
	Proportion of products from certified sources;
	Value of fines and sanctions for non-compliance with biodiversity laws and regulations;
	Level of investment in biodiversity;
	Number of employees that attended at least one biodiversity training session; and
	Percentage of entities trained in biodiversity issues (both under and outside the control of the reporting organization, e.g. suppliers, depending on the reporting boundaries)

1.3.3. Science Based Targets Network (SBTN) setting Science-based targets for nature

The Science-based Targets for nature is a framework that is repeatedly referenced in the TNFD's scope. TNFD highlights the importance of using scientifically anchored approaches when setting targets: "follow a scientifically anchored approach, incorporate well established and emerging scientific evidence and aim to incorporate other existing science-based initiatives.[157]

The Science Based Targets Network published its guidance for businesses for voluntary commitment to science-based targets (SBTs) in 2020. **Science-based targets are defined** as "measurable, actionable, and time-bound objectives, based on the best available science, that allow actors to align with Earth's limits and societal sustainability goals." SBTs offer a pathway for sufficiently ambitious corporate action for the future.

The SBTN aims to assist companies to align their efforts with global nature-related sustainability efforts, notably the goals set out by the Convention on Biological Diversity's (UNCBD) Post-2020 Global Biodiversity Framework, with goals including:

- area, connectivity and integrity of ecosystems (Draft Goal A)
- species extinction risk and abundance (Draft Goal A)
- nature's contributions to people valued, maintained or enhanced (Draft Goal B)

[157] TNFD. Nature in Scope-workplan

- The Convention to Combat Desertification's (UNCCD), 2018–2030 Strategic Framework, with the headline goal of land degradation neutrality
- The UNFCCC Paris Agreement to keep global temperature rise to 1.5°C
- The General Assembly's 2030 Agenda for Sustainable development SDGs 6, 12, 13, 14 and 15[158].

The targets align with the global nature-positive goal for nature. As defined by SBTN a nature-positive world requires no net loss of nature from 2020, a net-positive state of nature by 2030, and full recovery of nature by 2050. **This high-level goal is aligned with the UNCBD's current draft goal A, which includes a 5% increase in the extent, connectivity, and integrity of ecosystems as a milestone for 2030.**

Action against nature loss must address the key drivers and pressures on nature and reflect the structure of the UNCBD's draft Post-2020 Global Biodiversity Framework.[159]

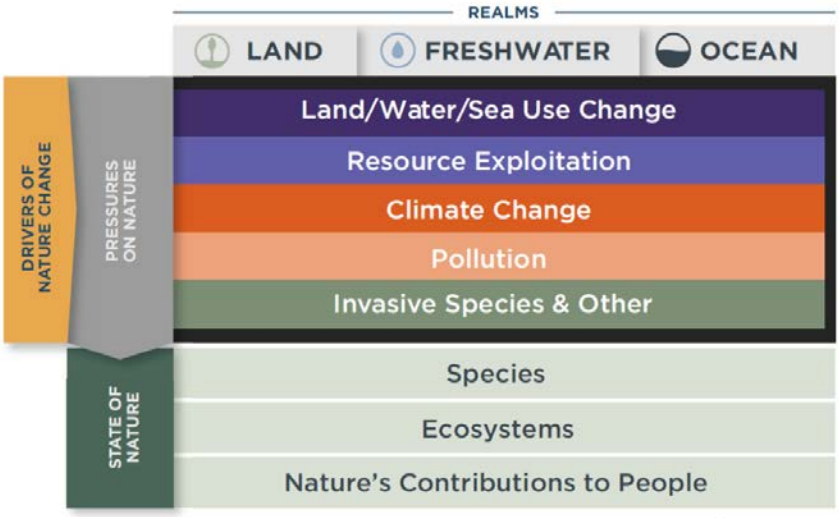

Fig.14: High-level target categories for SBTs for nature[160]

SBTN's action framework, called AR^{3}T, is built on the mitigation hierarchy set out in the International Financial Corporation's Performance Standard 6 (IFC PS6). As currently used, the mitigation hierarchy helps companies plan for and address their impacts on biodiversity **at a project level.** The AR^{3}T Framework is also built on the **conservation hierarchy**, which expanded the mitigation hierarchy concept, as will be analyzed in a following paragraph.

The four prioritized steps of the AR^{3}T action framework are:

- **Avoid** pressures on nature from happening in the first place; eliminate the impact entirely.
- **Reduce** pressures on nature (which would otherwise continue to grow), but without necessarily eliminating them.

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158 SDG6 Clean water and sanitation
SDG12 Responsible consumption and production
SDG13 Climate action
SDG14 Life below water
SDG15 Life on land

159 Science-based Targets Network. (September 2020). "Science-based Targets for Nature: Initial Guidance for Business."

160 Science-based Targets Network. (September 2020). "Science-based Targets for Nature: Initial Guidance for Business."

- **Restore** and **regenerate** so that the extent and integrity of nature can recover.
- **Transform** underlying systems, at multiple levels, to address the drivers of nature loss.

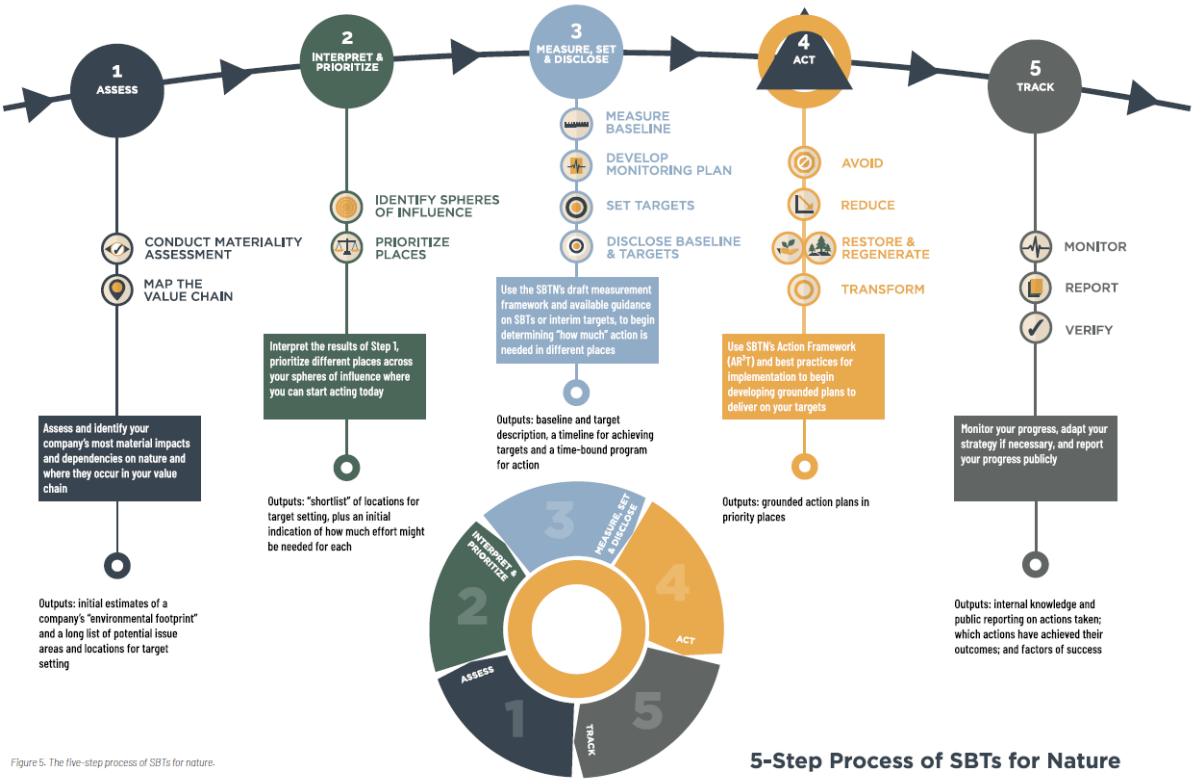


Fig. 15: The 5-step process of SBTs for nature

Table 20: Issue areas across realms and target categories where indicators aligned with SBTN's measurement principles have been identified.

		LAND	FRESHWATER	OCEAN
PRESSURES ON NATURE	Land/Water/Sea Use Change	Conversion & deforestation	Conversion & drainage	Conversion & dredging
		Habitat fragmentation		
	Resource Exploitation	Land degradation (net primary production, soil carbon)	Water use (withdrawal / consumption)	
		Overexploitation of land resources, e.g. unsustainable logging	Overexploitation of freshwater resources, e.g. fishing	Overexploitation of marine resources, e.g. fishing
	Climate Change	GHG Emissions		
	Pollution	Soil pollution	Water pollution	*Marine pollution*
	Invasive Species & Other	*Terrestrial invasives*	*Freshwater invasives*	*Marine invasives*
		Accidental mortality		
STATE OF NATURE	Species	Species population and abundance, species extinction rates		
	Ecosystems	Ecosystem extent, connectivity, and integrity		
	Nature's Contributions to People	*Various (e.g. pollination, water filtration, food provisioning)*		

SBTs or interim targets can be set	Baseline can be derived	*Data gathering is possible*

Table 21: SBTs

Target	Illustrative target wording	Initial guidance on target ambition for companies	Indicator	Alignment (with corporate reporting, global goals and Earth's limits)
Use Change (Land)	***Reduce*** to X by 2030 activities causing deforestation / conversion in your supply chain	***Zero deforestation from 2020 / Zero conversion of natural habitats in value chain by 2030;*** following Accountability Framework Initiative ***No net loss of non-forest natural habitats from 2020;*** following IFC Performance Standard 6	Deforestation / Conversion of natural ecosystems (ha)	Accountability Framework Initiative; CDP Forests SDG 15 (Life on Land) Planetary Boundaries on land use and biosphere integrity
Resource exploitation (Freshwater)	*By 2030, **reduce** water use in high water impact parts of the value chain by x%*	***Locally dependent;*** following Contextual Water Targets	water withdrawals (m^3)	GRI 303; CDP Water SDG 6 (Clean Water and Sanitation) Planetary Boundary on water
Resource exploitation (Ocean)	***Avoid*** sourcing from fisheries with stocks outside biologically sustainable levels	Ambition guidance coming soon	Proportion of fish sourced (%)	SDG 14 (Life Below Water) Planetary Boundary on biodiversity
Climate Change (Cross-Realm)	***Reduce*** value chain GHG emissions by X% by 2030	***>4.2%/year reductions for 1.5˚C alignment;*** following Science-based Targets Initiative	GHG emissions (tons CO_2e)	GRI 302; CDP Climate; GHG Protocol UNFCCC; SDG 13 (Paris Agreement) Planetary Boundary on climate change
Climate Change (Land)	After prioritizing GHG reductions, ***remove*** X tons CO_2 by 2030 through forest landscape restoration	Ambition guidance coming soon	CO_2 sequestered (tons CO_2e)	GHG Protocol UNFCCC; SDG 13 (Paris Agreement) Planetary Boundary on climate change
Ecosystems (Land)	***Regenerate*** ecological integrity in supply chain by ensuring X% ecological focus areas per km^2 for all sourced agricultural inputs	***10%*** per km^2; following European Commission definitions	Fraction of agricultural land in ecological focus areas at 1 km^2 scale (%)	UNCBD Post-2020 goal on area, connectivity, and integrity of natural ecosystems; SDG15 (Life on Land) Planetary Boundaries on land use and biosphere integrity European Commission policy
Ecosystems (Land)	Increase soil organic C by X%/year through ***restoration and regeneration*** in critical value chain sourcing locations by 2030	Ambition guidance coming soon	Soil C (tons C/ha)	Accounting for Natural Climate Solutions Guidance; Gold Standard UNCCD; SDG 15 (Life on Land) Planetary Boundary on climate change
Ecosystems (Cross-Realm)	Through **restoration**, increase the area, connectivity and integrity of natural ecosystems by X% by 2030	Ambition guidance coming soon	Extent, connectivity, and integrity (realm-specific indicators)	UNCBD Post-2020 goal on area, connectivity, and integrity of natural ecosystems; SDG 14 (Life Below Water); SDG 15 (Life on Land) Planetary Boundaries on land use and biosphere integrity
Species (Cross-Realm)	***Avoid*** sourcing from areas of high species extinction risk **Reduce** by X% extinction threat to species	Ambition guidance coming soon	Species Threat Abatement and Recovery (STAR)	IFC Performance Standard 6 UNCBD Post-2020 goal on species extinction; SDG 14 (Life Below Water); SDG 15 (Life on Land) Planetary Boundary on biosphere integrity

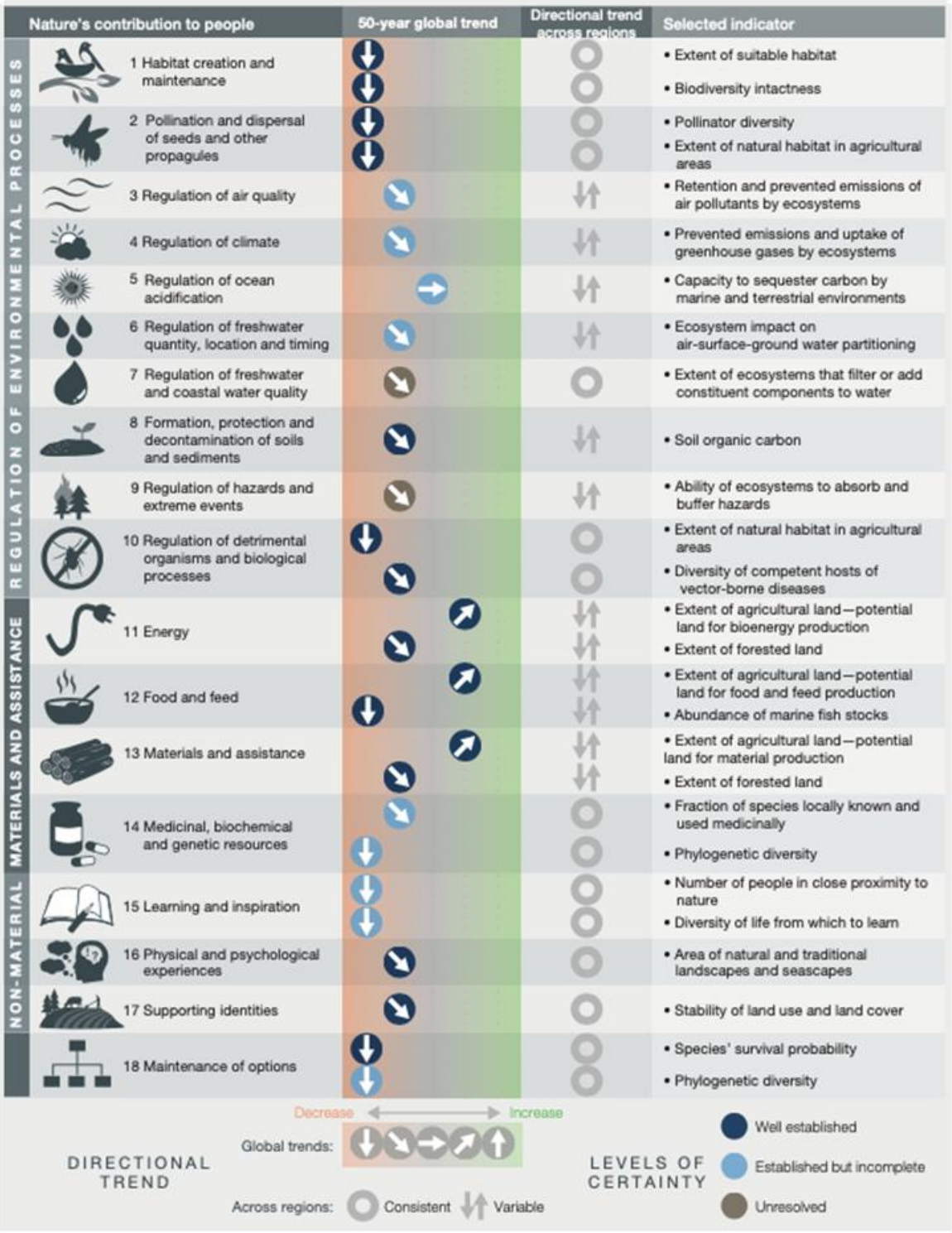
Table 7. Key illustrative and initial targets that are part of the SBTs for nature framework. This list is a subset of a broader crosswalk available in Technical Annex TA4.1, and examples are chosen for illustrative purposes—not to denote relative importance. Each target is shown along with the aligned measurement framework, including illustrative target wording, target indicator, and alignment to corporate accounting/reporting frameworks, societal goals, and planetary boundaries.

SBTs adopt similar terminology and express their objectives like UN frameworks, through three tiers: goals, targets, and indicators.

There are initial SBTs for:

- Land change: zero deforestation from 2020, zero conversion of natural habitats in value chain by 2030 and no net loss of non-forest natural habitats from 2020.
- Climate change: >4.2% per year reduction of value chain GHG emissions for 1.5^{o}C alignment
- Ecosystems (state): regeneration of 10% per km^2 of the ecological integrity in supply chain

Table 22: Applications of the AR^{3}T mitigation hierarchy[161]



[161] Table source: Science Based Targets Network (September 2020). "SBTs for Nature Initial guidance for business: Technical Annexes."

1.4. Key takeaways – common biodiversity-related management approaches and indicators

This section aims to highlight common biodiversity- related reporting features of management approaches, indicators, definitions of nature-related risks and opportunities in the reviewed ESG systems.

- TNFD, CDSB and SBTN explicitly seek alignment to CBD's draft global biodiversity goals.
- A key difference of the current approach of systems as compared to ESG systems approach so far is the detailed reporting of biodiversity dependencies(through the ecosystem services) that in previous approaches was limited to the inflows and outflows of water (quantity ad quality-wise), materials use and flood protection. Moreover, there is a direct connection with the pressures on biodiversity, including a biodiversity-specific pressure, the introduction of invasive species.
- Nature-related financial risks for businesses are determined by a company's impacts (pressures) and/ or dependencies on nature.
- The reviewed systems include example indicators that address:
  A. Pressures on biodiversity (or direct drivers of biodiversity loss).
  B. Change in the state of biodiversity
  C. Dependencies on biodiversity
  Though TNFD does not provide examples of specific indicators yet, it links nature-related risks with impacts and dependencies on nature.
- The state of biodiversity is defined through (1) species, (2) ecosystems and (3) ecosystem services. This is aligned with how the CBD's Draft Post-2020 Global Biodiversity Framework goals and targets for 2030 are structured., setting targets for (1) halting and reversing species extinction rate and maintaining and enhancing species abundance and distribution of populations (2) net gain in the area, connectivity and integrity of natural systems and (3) valuing, maintaining and enhancing nature's contributions to people and securing their provision in the long-term.
- In order to assess the materiality of biodiversity, information should be contextualized and business-specific. Focus should be given to those activities and outputs that are likely to impact biodiversity. The biodiversity- related context in a given location concerns priority species, ecosystems and geographical areas. Knowledge is required on the geographic specificity of biodiversity: the biodiversity status of the area, protected area status, biodiversity value, conservation status of species, ecosystem intactness, connectedness to other ecosystems, but also social conditions, including community traditions and livelihoods, e.g. dependence on nature-related productivity.[162]Finally, according to CDSB, contextualization of biodiversity information includes clarifying the connections with other environmental matters such as climate change, water or land use.

[162] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

- Reporting on biodiversity should address pressures and changes both on operations and the entire value chain.
- The well-established mitigation hierarchy is recognized as a key impact/ risk management and mitigation approach for structuring decisions towards nature-positive outcomes. Moreover, currently the mitigation hierarchy is supplemented and expanded through the conservation hierarchy allowing addressing impacts beyond operations, across the entire value chain and additionally allowing for the proactive consideration of conservation actions, such as protected area expansion or habitat restoration.

Following some tables are presented summarizing the results of ESG systems review:

Table 23: Overview of ESG systems' use of indicators per type of indicator: Pressures on Biodiversity (initial or draft and in the form of examples

Pressures on biodiversity		TNFD	CDSB	SBTN	WEF-IBC	GRI	SASB	GRESB
Land use change	extent		x	x	x	x	x	x
	quality			x				
Resource exploitation	water		x	x	x	x	x	x
	materials		x	x				
Climate change	GHG Emissions		x	x	x	x	x	x
	Physical risk							x
pollution	air		x		x	x	x	x
	water		x	x	x	x	x	x
	soil		x	x				x
	waste		x		x	x	x	x
	Noise pollution		x					x
	Light pollution		x					x
Introduction of invasive species			x	x				

Table 24: Overview of ESG systems' use of indicators per type of indicator: State of Biodiversity (initial or draft and in the form of examples)

State of biodiversity					
ecosystems					
CDSB	SBTN	WEF-IBC	GRI	SASB	GRESB
Mean Species Abundance					
Number or percentage of sites in which ecological richness is progressing /stable/ regressing					
Ecosystem/habitat cover change, e.g. forest area as a percentage of total land area or tree cover					

loss(ha)					
Ecosystem/Habitat fragmentation change (ha)					
	Ecosystem extent/ connectivity and integrity Soil C (tons C/ha)		Extent of areas impacted	Terrestrial acreage disturbed, percentage of impacted area restored	• Habitat removed • Habitat enhanced or restored • Habitat protected (on-site) • Habitat protected (off-site) • Net habitat gain • Habitat maintained
species					
Species population and abundance	x		Species affected		
Risk of species extinction			Reduction of species		
Areas (ha) of critical habitat for species in priority geographical areas					
Number of IUCN Red List species and national conservation list species within priority geographical areas			Biodiversity value characterized by listing of protected status Total number of IUCN Red List species and national conservation list species by level of extinction risk		threatened and endangered species fatalities (GRESB)
Number of invasive alien species identified on the organizations' sites/impact areas;					
Target taxa population sizes/abundance compared to actual population sizes					
Measurements of species populations and habitat diversity from on-the-ground studies					
	Species threat abatement and Recovery (STAR)				Wildlife fatalities
Final ecosystem services					
Water supply		Water supply	Water supply	Water supply	Water supply
Carbon sequestration		Carbon sequestration	Carbon sequestration	Carbon sequestration	Carbon sequestration
Flood protection					
Regulation of water		Regulation of water	Regulation of water	Regulation of water	Regulation of water

		Various as shown in table 23			

It is worth mentioning that some of the systems request reporting of the state of biodiversity, such as SBTN, and other request reporting of changes to the state of biodiversity, such as CDSB. GRESB requests both.

Table 25: Overlaps/links between types of indicators

Pressures on biodiversity		Dependencies	State of biodiversity		
			species	ecosystems	Ecosystem services
Land use change	extent			Ecosystem/habitat cover change	
	quality			Habitat fragmentation Soil carbon	
Resource exploitation	water	Water supply			Provision of water
	materials	Provision of materials (timber)			Provision of materials
Climate change	Emissions	Carbon sequestration for reaching net zero targets		Carbon storage capacity	Global climate regulation services
	Physical risk				Flood mitigation
pollution	air				
	water	Water purification (water quality amelioration)			Water purification (water quality amelioration)
	soil				
	waste				
	Noise pollution		x		Noise attenuation
	Light pollution		x		
Introduction of invasive species					

A key overlap is between ‘dependencies’ and ‘state of biodiversity: ecosystem services’ indicators that represents the supply and demand of ecosystem services. Moreover, there are overlaps/links between pressures and ecosystem services as some ecosystem services represent responses to pressures.

2. ECOSYSTEM ASSESSMENT AND ACCOUNTING FRAMEWORKS &THEIR ECOSYSTEM SERVICES CLASSIFICATION SYSTEMS

Ecosystem assessment frameworks and accounting systems will be reviewed to provide insight on:

(a) How performance is assessed in the case of ecosystems, and by extension to NbS,
(b) How the biodiversity-related risk and opportunities are communicated to decision-makers.

The systems reviewed represent various approaches to systematize the production of **evidence** on the provision of benefits by ecosystems and the connection between the condition of an ecosystem and its capacity to deliver services.

For the research, evidence of effectiveness in climate change mitigation and adaptation performance is of interest. However, a shared view is the potential of Nature-based Solutions to serve as climate change mitigation and adaptation solutions "**while producing additional co-benefits for the community's well-being.'**

Ecosystem accounting is a coherent and integrated approach to measuring ecosystem assets and services' flows into economic and other human activity (SEEA-EEA, 2012). Ecosystem accounting aims to record data systematically on the stocks and flows of selected ecosystems.[163]

Ecosystem assessment is defined as a social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers.[164] A full assessment of any service requires considerations of the service's stocks, flows, and resilience.

It is worth highlighting the difference between an ecosystem and ecosystem services-based framework and the standard environmental impact assessment (EIA). Ecosystem assessment differs because it places ecosystems and the environment central to reaching development goals. It is designed to examine how changes to ecosystems influence human outcomes. The EIA approach, in contrast, focuses on the impacts of human actions on the environment and is designed to explore the relative costs and benefits of various project alternatives. Ecosystems and the environment are externalities in an EIA (affected by development activities). In contrast, they are internal in the ecosystem assessment—something that can be managed sustainably to contribute to human development. [165]

The scale on which the assessment or accounting may be conducted varies: the ecosystems measured may range from specific land cover type areas, such as forests, to larger integrated areas, such as river

[163] UN Department of Economic and Social Affairs Statistical Division, SEEA. (February 2021). System of Environmental-Economic Accounting—Ecosystem Accounting. Final Draft. Version 5.

[164] Maes, J.et al. (2018) Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Publications office of the European Union, Luxembourg.

[165] Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment."

basins, and may include areas considered to be relatively natural and those that are heavily affected by human activity, such as agricultural areas.[166]

The review focuses on the conceptual frameworks behind integrated ecosystem accounting and assessment that provide "a concise summary of the relationships between people and nature, in other words, the key components of interactions between humans and ecological systems, including how those relationships may be changing over time."[167] They systematically link ecological systems that produce ecosystem services with human systems that directly use these services.

Conceptual frameworks can help organize thinking and structure the work needed when assessing complex ecosystems, social arrangements, and human-environment interaction. It should reflect what people value most about an ecosystem, which varies among different stakeholders' groups.[168] Therefore the structure and elements of a conceptual framework cannot be comprehensive; they need to focus on those issues perceived as most important for the assessment users. "The structure and elements of a framework also are the foundation for identification, prioritization, and development of appropriate indicators for conditions and trends in ecosystems."[169]

It is essential to have a clear definition and comprehensive classification of ES in ecosystem assessment and accounting. Moreover, "**a classification can operate as a checklist."**[170] For example, the consultation on CICES V4.3 (previous version) revealed that users had employed CICES both as a way to define ecosystem services and **as a set of reporting categories**.[171] Therefore, objective of the classification systems review is to eventually select a system upon which to build the Envision analysis.

In ecosystem accounting, ecosystems are accounted for in terms of assets (reflected in extent, condition, and monetary asset value) and ecosystem services. Ecosystem accounting aims explicitly to capture the flow of contributions to human production, consumption, and well-being, including material and non-material contributions concerning the condition of these ecosystems. [172, 173]

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166 https://ipbes.net/policy-support/tools-instruments/ecosystem-accounting

167 Ash, N. et al. (2010). Ecosystems and Well-being: A manual for assessment practitioners. Chapter 3, pg.72.

168 Ash, N. et al. (2010). Ecosystems and Well-being: A manual for assessment practitioners. Chapter 3.

169 Ash, N. et al. (2010). Ecosystems and Well-being: A manual for assessment practitioners. Chapter 3, pg.79.

170 Hein, L. et al. (September 2018). "SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Final Report.

171 Haines-Young, R. and M.B. Potschin. (January 2018). Common International Classification of Ecosystem Services (CICES) V5.1: Guidance on the Application of the Revised Structure." pg.11.

172 Hein, L. et al. (September 2018). SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Discussion paper.

173 In the case of provisioning services, the flow is typically measured in terms of biophysical production, such as kilograms of maize per hectare etc. The provisioning of ecological goods such as food, fuelwood, or fiber, depends both on the flow and the "stock" of the good.
In the case of regulating services, as opposed to provisioning services, the level of "production" is generally not relevant. Instead, the condition of the service depends more on whether the ecosystem's capability to regulate a particular service has been enhanced or diminished. (MA, 2003)

2.1. Overview of frameworks under review

Ecosystem services are the benefits people obtain from nature (MA 2003, 2005). Existing literature on ecosystem services proposes various definitions and classification approaches. Although there is broad consensus that ecosystems are natural assets that support human welfare, a consensus has not been reached on the best conceptual approach for describing and classifying the diverse processes, functions, stocks, flows, goods, services, and benefits embedded within or provided by ecosystems.

Seven approaches to the classification of ecosystem services will be briefly presented. These classification systems are in their majority part of a theoretical framework behind Ecosystem service-based assessment and accounting approaches:

- the Millennium Ecosystem Assessment[174] (MA) framework (2003, 2005);
- the De Groot et al. (2002);
- the US Environmental Protection Agency (EPA)'s National Ecosystem Services Classification System (NESCS) (2015, 2020);
- the European Environmental Agency's Common International Classification of Ecosystem Services (CICES)175 (2013, 2018)
- the United Nations' System of Environmental-Economic Accounting (SEEA-EA) (2014, 2021);
- the United Nations Environment Program (UNEP)'s 'The Economics of Ecosystems & Biodiversity' (TEEB) (2013); and
- The IPBES Nature's Contribution to People (NCPs) framework (2017)

MA, TEEB, and IPBES were proposed in global ecosystem assessments of the above classifications. CICES was developed from the work on environmental accounting undertaken by the European Environmental Agency (EEA) and has been adopted for mapping work on the European's Union's MAES (Mapping and Assessment of Ecosystems and their Services) project. SEEA EA was developed for global accounting. These approaches have built on one another and overlap to a great degree.

[174] The Millennium Ecosystem Assessment (MA) was called for by the United Nations Secretary-General Kofi Annan in 2000. Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being, launched by the UN. (source: https://www.millenniumassessment.org/en/About.html)

[175] CICES has been used by the EU for the Mapping and Assessment of Ecosystem Services (MAES)

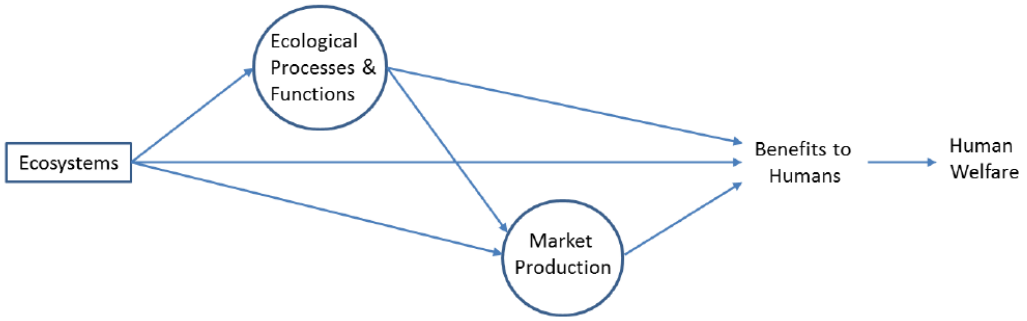


Fig. 16: Simple Conceptual Framework underlying most ecosystem service definitions and classification systems (Source: NESCS, 2015)

One of the earlier studies and one of the most widely cited ecosystem classifications was the Millennium Ecosystem Assessment (MA) of 2003 that 'introduced the concept of ecosystem services in the global agenda" and "provided an important bridge between the imperatives of maintaining biodiversity and the challenges in meeting the Millennium Development Goals."[176] MA was mainly devoted to developing an inventory of ecosystem services and ensuring that the analysis addresses the entire range of services. However, overlaps existed between services.[177,178]

Subsequent work in the context of the TEEB (The Economics of Ecosystems and Biodiversity) study (TEEB, 2010), the MAES initiative (MAES et al., 2014), and the Inter-governmental Platform on Biodiversity and Ecosystem Services (IPBES) have further developed the concept of ecosystem services and provided further evidence of the potential of the ecosystem services approach in understanding the relationship between humans and the environment. These global or regional assessments have yielded a new typology or classification system for ecosystem services. There are both differences and similarities between the various existing typologies/classification systems. A common element is that the various systems differentiate ecosystem assets, ecosystem services, and economic units. Differences pertain to the exact definition of services, categories, and type of services included and distinguished.[179]

An overview of these approaches will be presented in the following paragraphs. Though these approaches intend a comprehensive accounting for ecosystem services, due to the present research's primary focus on climate change, the analysis will eventually explore those ecosystem services related to climate change in more detail.

[176] TEEB. (2010). The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations

[177] United States Environmental Protection Agency (US EPA). (September 2015). "National Ecosystem Services Classification System (NESCS): Framework Design and Policy Application." EPA-800-R-15-002. United States Environmental Protection Agency, Washington, DC.

[178] It is worth mentioning that the widely cited Millennium Ecosystem Assessment framework that divides ecosystem services into supporting, provisioning, cultural, and regulating service and was used for the Zofnass Landscape as Infrastructure approach.

[179] Hein, L. et al. (September 2018). SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Discussion paper.

2.1.1. Millennium Ecosystem Assessment framework (MA, 2003)

The Millennium Ecosystem Assessment was a four-year international work program launched by the UN and designed to meet the needs of decision-makers for scientific information on the links between ecosystem change and human well-being. The identified problem was “growing demand for ecosystem services at the same time compounded by increasingly serious degradation in the capability of ecosystems to provide these services.” “The goal of the MA was to establish the scientific basis for actions needed to enhance the contribution of ecosystems to human well-being without undermining long-term productivity.”

The conceptual framework for the MA places human well-being as the central focus for assessment while recognizing that biodiversity and ecosystems also have intrinsic value and that people make decisions concerning ecosystems based on considerations of both well-being and inherent value.

The MA conceptual framework assumes that a dynamic interaction exists between people and ecosystems, with the changing human condition, directly and indirectly, driving change in ecosystems and with changes in ecosystems causing changes in human well-being. At the same time, many other factors independent of the environment change the human condition, and many natural forces influence ecosystems. A full assessment of the interactions between people and ecosystems requires a multi-scale approach.

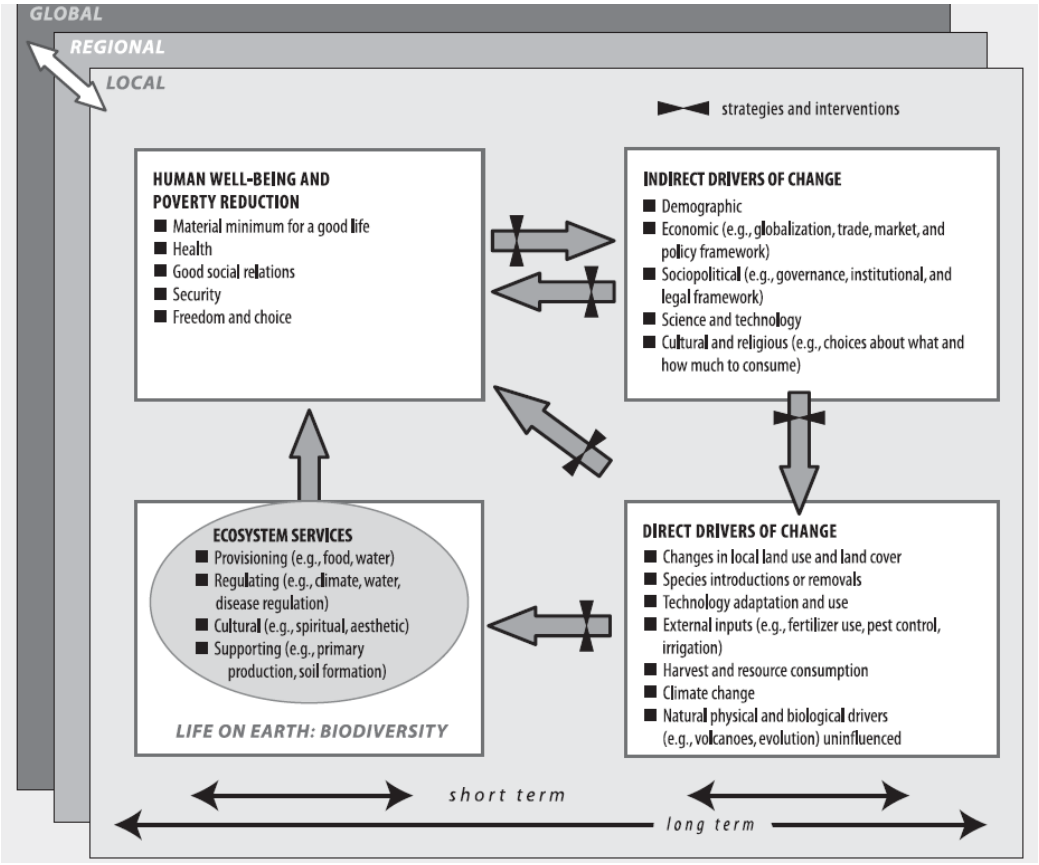


Fig. 17: Millennium Ecosystem Assessment conceptual framework[180]

MA defines ecosystem services as 'the benefits people obtain from ecosystems.' According to the MA framework, ecosystem services include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services.

- Provisioning services are products obtained from ecosystems (e.g., food, freshwater, fuel/wood, fiber, biochemicals, and genetic resources)
- Regulating services are benefits from regulation of ecosystem processes (e.g., climate regulation, disease regulation, water regulation and purification, pollination)
- Cultural services are non-material benefits obtained from ecosystems (e.g., spiritual and religious, recreation and ecotourism, aesthetic, educational, and other)
- Supporting services are those services that are necessary to produce all other ecosystem services (soil formation. nutrient cycling, primary production)[181]

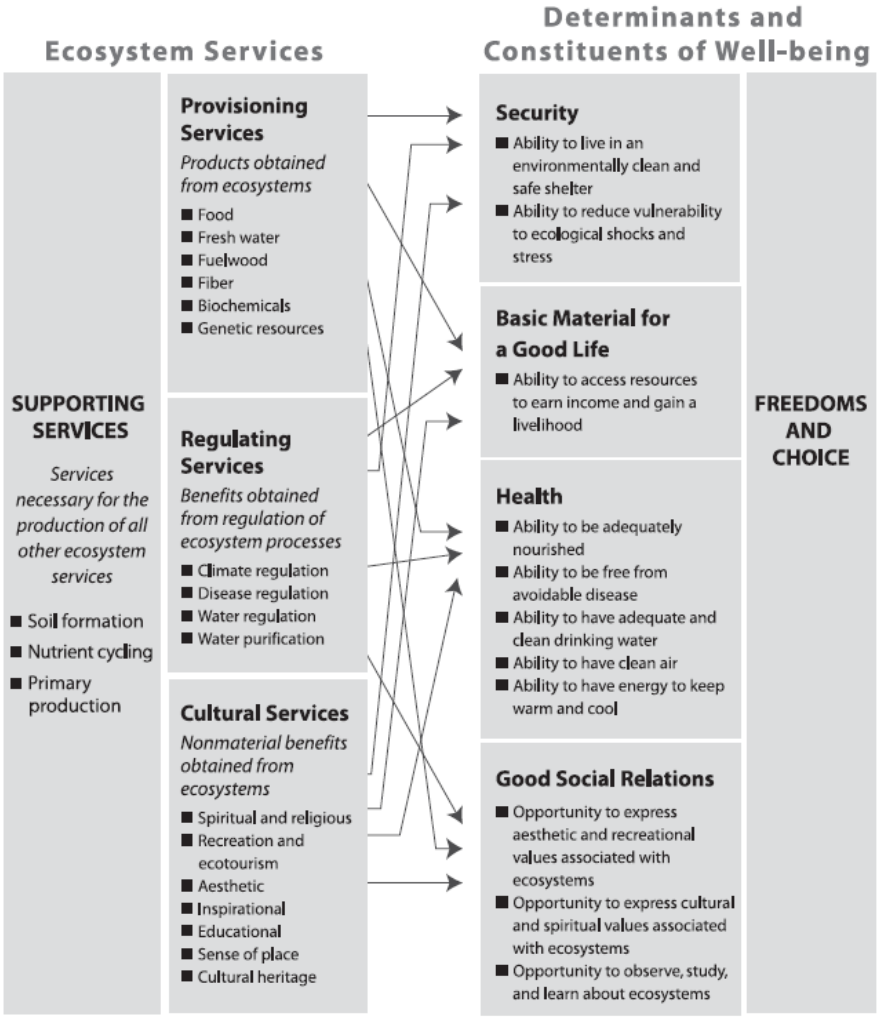
[180] Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment." A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment.

[181] Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment." Island Press. A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment.

A key distinction between the MA and the other ES typologies concerns the omission of the 'supporting' category of ES in the others. However, the Millennium Ecosystem Assessment report emphasizes that "the purpose [of these categories] is not to establish a taxonomy but rather to ensure that the [MA] analysis addresses the entire range of services."[182] According to criticism to MA, most of the services under the regulating and supporting categories are processes rather than services.

MA states that "the condition of each category of ecosystem services is evaluated in somewhat different ways, although in general, a full assessment of any service requires considerations of stocks, flows, and resilience of the service."

Table 26: MA classification of ecosystem services and their links to human wellbeing[183]



[182] https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-plus-frequently-asked-questions

[183] Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being: A framework for assessment." Island Press. A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment.

2.1.2. Study of De Groot et al. (2002)

The De Groot et al. study supports comparative ecological, economic analyses. The authors present a "conceptual framework and typology for describing, classifying and valuing ecosystem functions, goods, and services." The study emphasizes the importance of translating complex ecological structures and processes to a limited number of ecosystem functions, defined as "the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly."[184] Ecosystem functions thus are antecedents to ecosystem goods and services. The study groups 23 ecosystem functions and their associated ecosystem goods and services into four broad categories:

- Regulation functions.
- Habitat functions.
- Production functions.
- Information functions.

Regulation and habitat functions are essential to the maintenance of natural processes and components and are therefore conditional to maintaining the availability of production and information functions.[185]

The study says that 'the ecosystem function-concept provides the empirical basis for classifying (potentially) useful aspects of natural ecosystems to humans: observed ecosystem functions are re-conceptualized as 'ecosystem goods or services' when human values are implied. The primary insight is that the concept of ecosystem goods and services is inherently *anthropocentric*: human beings' presence as valuing agents that translate basic ecological structures and processes into value-laden entities.

2.1.3. The Economics of Ecosystems and Biodiversity (TEEB)

The TEEB initiative was launched in 2007 by the United Nations Environment Program (UNEP). Centered on economic valuation, TEEB aims to help decision-makers recognize the economic benefits of biodiversity and the growing cost of ecosystem degradation. TEEB defined ecosystem services as 'the direct and indirect contributions of ecosystems to human well-being.[186] TEEB based on MA provides an updated classification used in ongoing national studies across Europe.

TEEB proposes a typology of 23 ecosystem services divided into four main categories; provisioning, regulating, habitat, and cultural & amenity services. [187]

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[184] The use of ecosystems functions as a subset of ecosystem processes that provide services has been criticized as redundant to ecosystem process. (source: NESCS, 2015)

[185] De Groot, R., Wilson A., M. and Boumans, M.J., R. (June 2002). "A typology for the classification, description and valuation of ecosystem functions, goods and services." *Ecological Economics* Volume 41, Issue 3, Pages 393-408 (Special Issue on "The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives")

[186] TEEB. (March 2010). The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations.

[187] TEEB. (March 2010). The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations, p.21.

TEEB includes the category of 'habitat service,' not included in MA. This is also the case of IPBES, as will be seen in the relevant section. The inclusion of this category shows the position of TEEB and IPBES in the question 'if biodiversity is also an ecosystem service.' Biodiversity is included as a service. An argument to be considered is that biodiversity can be degraded or enhanced over time. Therefore, it has more of a stock character than a flow character. It is more the human interaction with biodiversity supported by CICES and SEEA EA, which include specific attributes of biodiversity as part of their cultural services.[188]

2.1.4. The National Ecosystem Services Classification System (NESCS)

The NESCS classification system was developed by the US Environmental Protection Agency (EPA) to "provide a framework that will aid in analyzing the human welfare impacts of policy-induced changes to ecosystems. It is intended to support different policy impact analyses, such as cost-benefit analysis of environmental regulations." NESCS is primarily designed to identify ecosystem service changes and provide a foundation for subsequent quantification and valuation. It is not an accounting system, but it is designed to support comprehensive and systematic accounting of changes in ecosystem services.[189]

NESCS defines 'flows of final ecosystem services' by matching together elements from four sub-classifications, one like an ecosystem asset, one the ecological end-products of nature, one for use types of these end-products, and one for the types of users, for thousands of possible combinations of final ecosystem services. Specific for NESCS is that they include types of users/beneficiaries as discriminatory components within their definition of ecosystem services.[190]

[188] Hein, L. et al. (September 2018). SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Discussion paper.

[189] EPA, Office of Water Office of Research and Development. (September 2015). National Ecosystem Services Classification System (NESCS): Framework Design and Policy Application. Final Report.

[190] Hein, L. et al. (September 2018). SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Discussion paper.

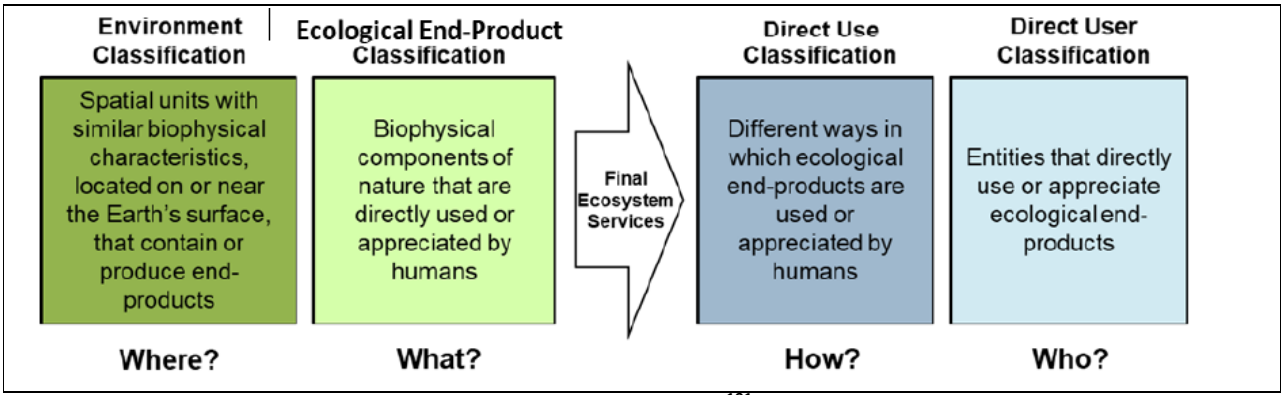


Fig. 18: The NESCS Plus "Use/User" structure (four components)[191]
The green half of the figure includes a simplified representation of the "ecological production" processes. These processes produce the biophysical components of nature (a "good") that are directly beneficial to or directly valued or used by humans, more specifically, as "Ecological End-Products. The blue half of the figure provides a simplified representation of human production and consumption of economic goods and services and their contribution to human well-being.

NESCS does not include a specific list of ecosystem services (these are defined based on the various interactions between ecosystem assets, end products of nature, use types, and user types). NESCS Plus employs a nested hierarchical structure for all the classification components so that each component can be represented at multiple levels of aggregation or detail. The four classification components can be used to identify individual final ES. More specifically, each unique combination – with a single element drawn from each of the four components – defines a separate potential final ES. The ability to define different combinations allows the NESCS Plus structure to be flexible and comprehensive and may result in numerous final ecosystem services.

[191] Newcomer-Johnson, T., Andrews, F., Corona, J., DeWitt, T.H., Harwell, M.C., Rhodes, C., Ringold, P., Russell, M.J., Sinha, P., and G. Van Houtven. (December 2020). "National Ecosystem Services Classification System (NESCS) Plus." U.S. Environmental Protection Agency. EPA/600/R-20/267.

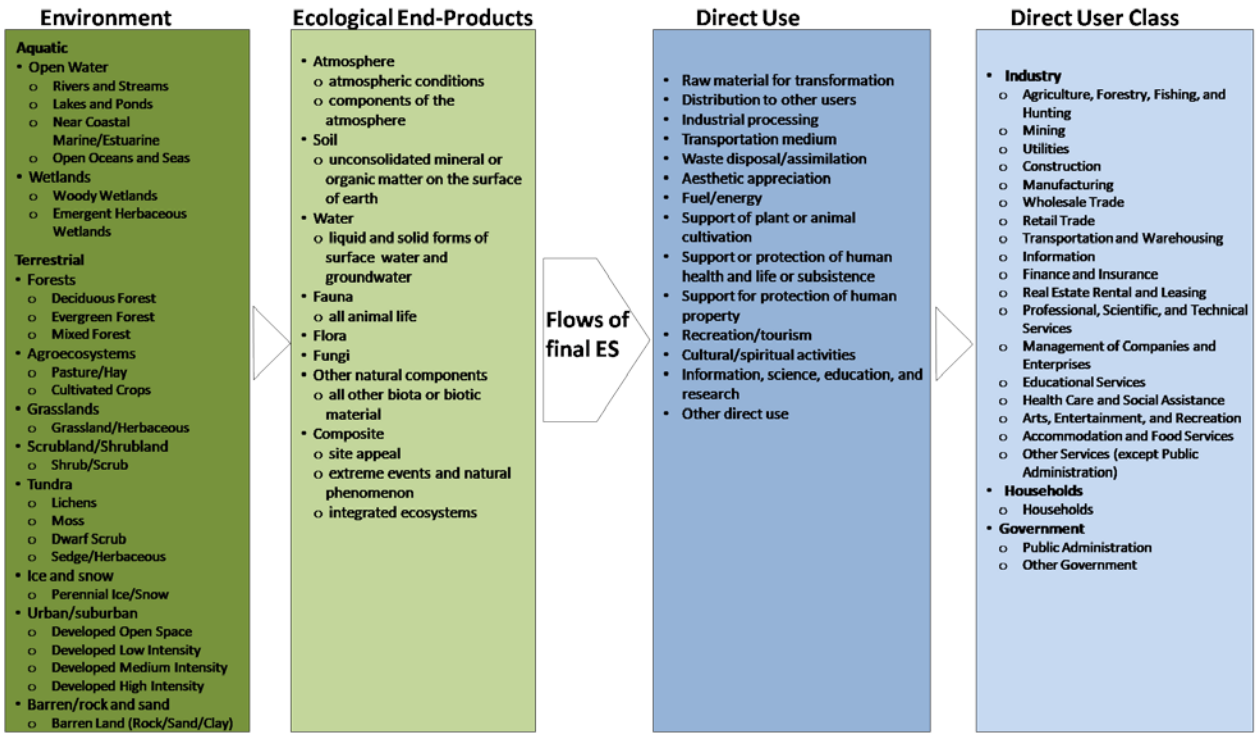


Fig. 19: NESCS 4-Group Structure (adapted from NESCS, 2015 based on NESCS Plus, 2020)

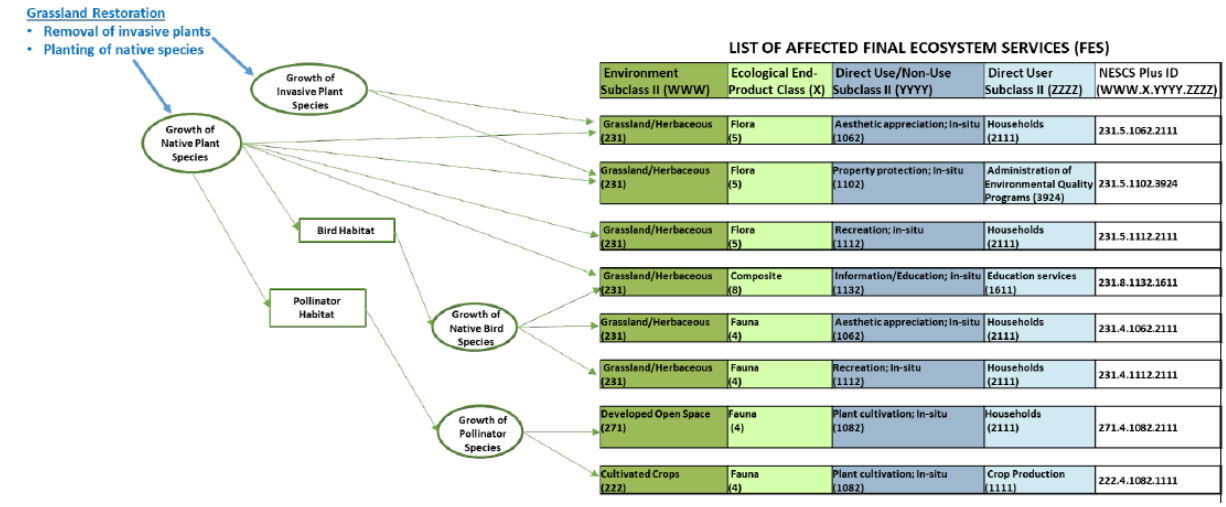


Fig. 20: Example of a nested hierarchical structure where a component is represented at multiple levels of aggregation or detail: Landfill Restoration conceptual model linking the environment to a tabular list of final ES. Components of ecosystems are represented in green and human systems in blue. Boxes represent stocks, arrows represent flows, and circles represent processes in the flow diagram. (Source NESCS Plus, 2020)

2.1.5. The Common International Classification of Ecosystem Services (CICES)

CICES was developed from the work on environmental accounting undertaken by the European Environment Agency (EEA) and was used in the EU-led work on Mapping and Assessment of Ecosystems

and their Services (MAES). The first operational version was published in 2013, and a recently revised version has been available since 2018. CICES took as a starting point the approach of the Millennium Ecosystem Assessment for describing ecosystem services and then refined it to reflect some of the key issues identified in the broader research literature. It adapted and expanded the MA approach to provide a more systematic and detailed classification system differentiating between intermediate and final ecosystem services.[192]

In CICES, ecosystem services are the *contributions* ecosystems make to human well-being and distinct from the goods and benefits that people derive from them. These contributions are framed as 'what ecosystems do' for people. Thus, in the revised version, the definition of each service identifies both the purposes or uses that people have for the different kinds of ecosystem service *and* the specific ecosystem attributes or behaviors that support them.[193] However, they also emphasize that whatever terminology is used, a mix of structures, processes, and functions generates the services that ultimately benefit people.[194]

CICES has helped resolve subtle structural and theoretical differences between the classification schemes and has become an increasingly important reference frame for various ES research lines. CICES is based on the cascade framework (Haines-Young and Potschin, 2010) and endeavors to link underlying ecological structures and processes to the well-being benefits received by human beings (La Notte et al., 2017).

[192] Roy Haines-Young and Marion Potschin (2010a, 2010b, 2013): Common International Classification for Ecosystem Services (CICES)

[193] Haines-Young, R. and M.B. Potschin (2018): Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure.

[194] United States Environmental Protection Agency (US EPA). (September 2015). "National Ecosystem Services Classification System (NESCS): Framework Design and Policy Application." EPA-800-R-15-002. United States Environmental Protection Agency, Washington, DC.

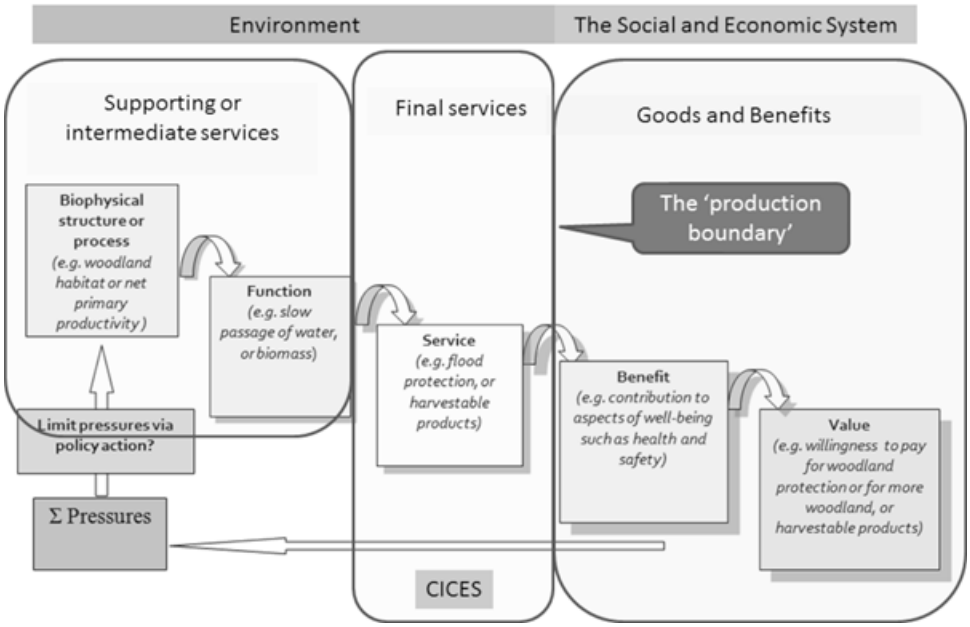


Fig. 21: The ecosystem services cascade model (source: Haines-Young, R. and M.B. Potschin, 2018)

The cascade model provides the conceptual framework in which CICES is set.

CICES uses the threefold division of:

- Provisioning services.
- Regulating and maintenance services.
- Cultural services.

CICES uses the label 'regulation and maintenance services' rather than 'regulating services/NCPs' (as in MA, TEEB, and IPBES)' because it is not straightforward to distinguish the regulation of flows from the mediation of physical conditions. CICES identifies 67 classes of biotic ecosystem services, plus 23 'abiotic' ecosystem services, such as providing opportunities to extract geothermal energy. It seeks to identify only the "final services" of ecosystems that directly contribute to human well-being — thus, the 'supporting' services of the MA are not included.

A fundamental characteristic of final services is that they retain a connection to the underlying ecosystem functions, processes, and structures that generate them. On the 'supply side' of the cascade, the idea of 'function' highlights those characteristics of the living system that come together to make something a service[195].

Provisioning services cover all nutritional, non-nutritional material, and energetic outputs from living systems and abiotic outputs (including water); regulation and maintenance services include how living organisms can mediate or moderate the ambient environment that affects human health, safety, or

[195] Haines-Young, R. and M.B. Potschin. (January 2018). Common International Classification of Ecosystem Services (CICES) V5.1: Guidance on the Application of the Revised Structure."

comfort, together with abiotic equivalents. Cultural services include non-material and normally non-rival and non-consumptive ecosystems (biotic and abiotic) that affect people's physical and mental states.[196]

CICES and NESCS can be seen as supplementary. The CICES defines services following a hierarchical structure based on uses and flows. The NESCS provides a systemic approach to classification, including nested hierarchical structures for types of ecosystems, ecological endpoints, types of uses, and types of beneficiaries.[197]

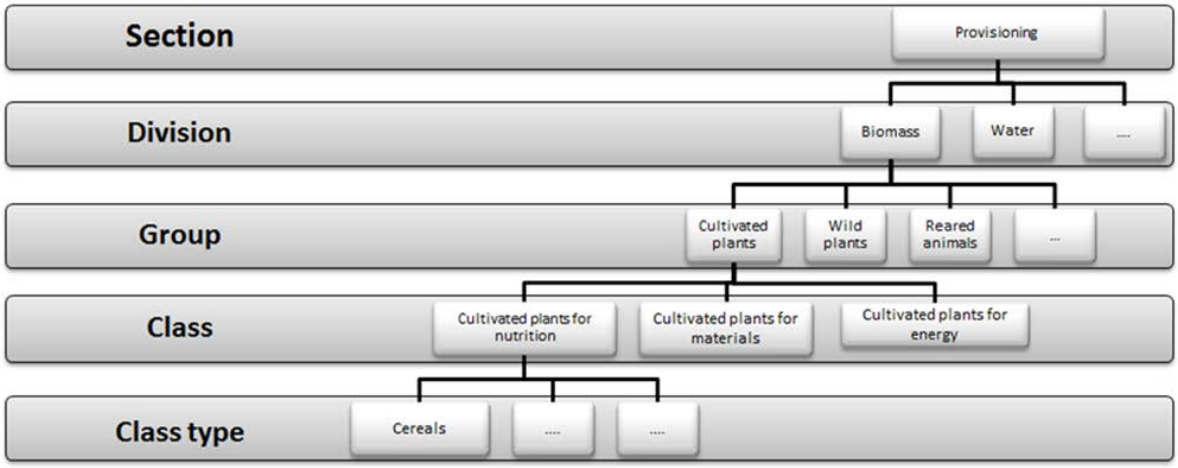


Fig. 22: The hierarchical structure of CICES V5.1 (source: Haines-Young, R. and M.B. Potschin, 2018)

2.1.6. The IPBES Nature's Contributions to People (NCPs)

Within the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the term "ecosystem services" and its subtypes have since 2018 been superseded by the terminology associated with the conceptual framework referred to as "nature's contributions to people" (NCPs). NCPs is an alternative term for ecosystem services that includes most – but not all – of the specific components previously under ecosystem services. NCP "is a more encompassing term than one of the ecosystem services."[198] What were formerly known as supporting services are excluded to avoid double-accounting. NCPs build on the ecosystem services concept to encompass "contributions, both positive and negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life." As part of the explanation of the logic for adopting the term, IPBES states:

[196] Haines-Young, R. and M.B. Potschin (2018): Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure.

[197] Lars Hein. (September 2018). "SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA."

[198] Davies, K.et al. Chapter 2: Nature's contributions to people and quality of life. In IPBES (2018): The IPBES regional assessment report on biodiversity and ecosystem services for Asia and the Pacific. Karki, M., Senaratna Sellamuttu, S., Okayasu, S.,Suzuki, W. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem services, Bonn, Germany.

"Creating a new term to supersede ecosystem services had several justifications. First, the original ecosystem services definition defined four subtypes (provisioning, cultural, regulatory, and supporting), but practitioners recognized that many services fit into more than one of the four categories. Secondly, IPBES wished to make explicit that positive and negative effects were included. Thirdly, the term 'services' had its origin in economics, which was perceived in some worldviews to be too narrow a formulation of the relationships between nature and people. The new language is considered more inclusive."[199]

IPBES developed[200] a classification system for NCPs in 2017 to use its ongoing and future global and regional assessments to provide consistent reporting. It is firmly rooted in the ecosystem services classification used by the Millennium Ecosystem Assessment (MA) and evolve3d based on a decade of interdisciplinary thinking, increasing involvement of social sciences and humanities.

The classification distinguishes three broad groups of NCPs: regulating, material and non-material. These represent different facets of the complex flow from nature to a good quality of life, ranging from indispensable direct biological connections (e.g., oxygen, water) to symbolic components that give meaning to the identity of different social groups and their relationships with nature.

The classification places a significant emphasis on the fact that the cultural context influences the perception and experiences by people of NCP and stresses the importance of socio-cultural relations between people and nature. To reflect this critical dimension in the classification, cultural ecosystem services are no longer a separate category but instead included in sub-categories in each of the three main groups of NCPs. IPBES also captures 'disservices,' negative interactions between people and ecosystems, such as those resulting from pests and carnivores eating livestock.

As compared to other classification systems, IPBES captures non-anthropocentric values, which can be reflected as ecosystem health, ecosystem condition, diversity, in its 'values of nature.'[201] IPBES proposes a set of 18 categories of NCPs listed below.

2.1.7. SEEA EA Ecosystem Services Reference List

The Environmental-Economic Accounting (SEEA) is an internationally agreed statistical system that combines environmental and economic information into one common framework. Ecosystem Accounting is one of the thematic areas of SEEA.[202] The SEEA Ecosystem Accounting (SEEA EA) constitutes an integrated and comprehensive statistical framework for organizing habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this

[199] IPBES Report Glossary

[200] Developed by members of the Multidisciplinary Expert Panel (MEP), in collaboration with experts of the regional and of the global assessments and the IPBES task forces.

[201] Lars Hein, with inputs from Ken Bagstad, Neville Crossman, Sander Jacobs, Alessandra La Notte, Carl Obst and UNSD. (September 2018). "SEEA Experimental Ecosystem Accounting: Towards a definition and classification of ecosystem services for SEEA." Final Report.

[202] Other thematic areas are Agriculture, Forestry and Fisheries, Air Emissions Accounts, Energy, Environmental Activity Accounts, Land Accounts, Material Flow Accounts and Water.

information to economic and other human activity. SEEA EA was adopted by the UN Statistical Commission in March 2021 and has already been used to inform policy development in more than 34 countries.[203] It revised the SEEA Experimental Ecosystem Accounting of 2012, the initial step in developing a statistical framework for ecosystem accounting supported by the UN, the European Commission, the Food and Agriculture Organization of the UN, the OECD, and the World Bank Group.

The SEEA EA is built on five core accounts:

1. Ecosystem extent accounts record the total area of each ecosystem classified by type, illustrating the changes in extent over the accounting period.
2. Ecosystem condition accounts record the condition of ecosystem assets in terms of selected characteristics at specific points in time.

3 & 4. Ecosystem services flow accounts (physical and monetary) record the supply of ES by ecosystem assets and the use of those services by economic units.

5. Monetary ecosystem asset accounts record information on stocks and changes (additions and reductions) of ecosystem assets. It includes accounting for ecosystem degradation and enhancement.

As part of the ecosystem services flow accounts, SEEA EA has developed a reference list of ecosystem services. SEEA EA pursued alignment with CICES because of the significant work on this framework and explicitly considered NESCS and combined findings from MA, TEEB, and IPBES-NCP. The reference list contains only selected ecosystem services and is not a full ecosystem service classification system. According to SEEA EA, it is intended that "a complete and internationally agreed classification system for ecosystem services will be developed, that will also allow users using existing classification systems (CICES, NESCS) to link to the reference list."

SEEA EA defines ecosystem services as the contributions of ecosystems to the benefits that are used in economic and other human activity. The reference list includes ecosystem services that can be final (i.e., used by economic units) or intermediate services (i.e., used by ecosystem assets). Further, particularly for regulating and maintenance services, one ecosystem service may be final or intermediate depending on the context.

The SEEA EA reference list is structured into three broad categories:

- Provisioning services- *ecosystem services represent the contributions to benefits extracted or harvested from ecosystems.*
    - Regulating and maintenance services – *ecosystem services resulting from the ability of ecosystems to regulate biological processes and influence climate, hydrological and biochemical cycles, and thereby maintain environmental conditions beneficial to individuals and society.*

[203] https://seea.un.org/ecosystem-accounting

- Cultural services – *the experiential and intangible services related to the perceived or actual qualities of ecosystems whose existence and functioning contribute to a range of cultural benefits.*[204]

2.2. Cross-comparison and Selection of ES Classification System for Detailed Analysis

A mapping table of the regulating ecosystem services per classification system has been developed.[205] Among the categories of ecosystem services the regulating and provisioning services have been selected as those categories that are more relevant to climate change mitigation and adaptation, as compared to cultural services.

Purpose of this cross-comparison is to select an ecosystem services classification system to use for the Envision review. A classification can act as a checklist or a set of reporting categories against which to map Envision and how it assesses nature-related performance. More specifically, ecosystem services coincide with companies' or projects' dependencies on nature and thus will complement the overall review process.

[204] UN Department of Economic and Social Affairs Statistical Division, SEEA. (February 2021). System of Environmental-Economic Accounting—Ecosystem Accounting. Final Draft. Version 5.

[205] The table adapts and enhances the UN SEEA "Online supplement: Ecosystem Services Reference List Crosswalk to Selected Ecosystem Services Classifications and Typologies", Version 1, July 2021.

Table 27: Cross-comparison of Regulating Services across Ecosystem services Classification systems

SEEA Services		CICES (v5.1) Class	IPBES	MA	TEEB	
Global climate regulation services (regulation of the chemical composition of the atmosphere and oceans)		Regulation of chemical composition of atmosphere and oceans	Regulation of climate	Climate regulation	Climate regulation	Carbon sequestration
						Climate regulation(unspecified)
						Gas regulation
			Regulation of ocean acidification			
Rainfall pattern regulation services (at sub-continental scale)		Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	Regulation of climate (biophysical feedbacks from vegetation cover to atmosphere such as evapotranspiration	Water regulation	Regulation of water flows	Water regulation (unspecified)
					Moderation of extreme events	Flood protection
				Water cycling (supporting service)		
Local (micro and meso) climate regulation services		Regulation of temperature and humidity, including ventilation &transpiration	Regulation of climate	Climate regulation	Climate regulation	Microclimate regulation
Air filtration services		Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	Regulation of air quality	Air quality regulation	Air quality regulation	Capturing fine dust
		Regulation of chemical composition of atmosphere and oceans				Air quality regulation (unspecified)
		Smell reduction				UVb protection
		Dilution by atmosphere (by non-living processes)				
		Mediation by other chemical or physical means (e.g. via filtration, sequestration, storage or accumulation)				
Soil quality regulation services		Weathering processes and their effect on soil quality	Formation, protection and decontamination of soils and sediments	Soil formation Nutrient cycling (supporting services)	Maintenance of soil fertility	Maintenance of soil structure
						Deposition of nutrients
						Soil formation
						Nutrient cycling
		Decomposition and fixing processes and their effect on soil quality			Waste treatment	Soil detoxication
Soil and sediment retention services	Soil erosion control services	Control of erosion rates		Erosion regulation	Erosion prevention	Erosion prevention
	Landslide mitigation	Buffering and attenuation of mass movement	Regulation of hazards and extreme events (like landslides, avalanches)			
Solid waste remediation		Bio-remediation by micro-organisms, algae, plants, and animals	Formation, protection and decontamination of soils and sediments	Water purification and waste treatment	Waste treatment	Waste treatment (unspecified)
		Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	Regulation of organisms detrimental to humans			
Water purification services (water quality amelioration)	Retention and breakdown of nutrients	Regulation of the chemical condition of freshwaters by living processes	Regulation of freshwater and coastal water quality (through filtration of particles, pathogens, excess nutrients, and other chemicals by ecosystems or particular organisms)	Water purification and waste treatment	Waste treatment	Water purification
	Retention and breakdown of other pollutants	Regulation of the chemical condition of salt waters by living processes		No equivalent	No equivalent	
Water flow regulation services	Baseline flow maintenance services	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	Regulation of freshwater quantity, location and timing	Water regulation	Regulation of water flows	Drainage
						River Discharge
						Natural irrigation
						Water regulation (unspecified)
	Peak flow mitigation services				Moderation of extreme events	Prevention of extreme events (unspecified)
Flood mitigation services	Coastal protection services	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	Regulation of hazards and extreme events	Water regulation	Moderation of extreme events	Flood prevention
	River flood mitigation services	Regulation of baseline flows and extreme events (by abiotic structures or processes): Liquid flows				
Storm mitigation services		Wind protection		Storm /Natural hazard regulation	Moderation of extreme events	Storm protection
		Buffering and attenuation of mass movement				
		Regulation of baseline flows and extreme events (by abiotic structures or processes): Mass flows				
Noise attenuation services		Noise attenuation	Regulation of hazards and extreme events (high noise levels)	No equivalent	Waste treatment	Abatement of noise
Pollination services		Pollination (or 'gamete' dispersal in a marine context)	Pollination and dispersal of seeds and other propagules	Pollination	Pollination (Sub-services:	Pollination of crops
						Pollination of wild plants
						Pollination (unspecified)
[Not specified]		Seed dispersal		No equivalent	Biological control	Seed dispersal
Biological control services	Pest control services	Pest control (including invasive species)	Regulation of organisms detrimental to humans	Pest regulation	Biological control	Pest control
	Disease control services	Disease control		Disease regulation	Biological control	Disease control
Nursery population and habitat maintenance services		Maintaining nursery populations and habitats (Including gene pool protection)	Habitat creation and maintenance(formation and continued production of ecological conditions	Primary production Nutrients cycling	Maintenance of life cycles of migratory species	Nursery service

			necessary or favorable for habitats)	Provisioning of habitat (supporting services)	Maintenance of life cycles of migratory species	Refugia for migratory and resident species
					Maintenance of genetic diversity (especially in gene pool protection)	Biodiversity protection
Other regulating and maintenance services	[not specified]	Fire protection		[Not specified]	Moderation of extreme events	Fire prevention

Table 28: Cross-comparison of Provisioning Services across Ecosystem services Classification systems

SEEA		CICES (v5.1) Class	IPBES	MA	TEEB	
Biomass provisioning services	Crop provisioning services (food and fiber production, fodder and energy)	Cultivated terrestrial plants (incl. fungi, algae) grown for nutritional purposes	Food and feed	Food	Food	Plants/vegetable food)
		Wild plants (terrestrial and aquatic, incl. fungi, algae) used for nutrition				
					Raw materials	Fibers
						Biomass fuels
	Grazed biomass provisioning services	Fibers and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources	Fibre, Timber, Ornamental, Biochemical	Raw materials	Fodder
	Livestock provisioning services	Animals reared for nutritional purposes	Food and feed		Food	Meat
		Fibers and other materials from reared animals for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources		Raw materials	Fertilizer
	Aquaculture provisioning services	Plants cultivated by in- situ aquaculture grown for nutritional purposes	Food and feed	Food	Food	Plants / vegetable food
		Fibers and other materials from in-situ aquaculture for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources	Fibre, Timber, Ornamental, Biochemical	Raw materials	Fibers
		Plants cultivated by in- situ aquaculture grown as an energy source	Energy			
		Animals reared by in-situ aquaculture for nutritional purposes	Food and feed	Food	Food	Fish
		Fibers and other materials from animals grown by in-situ aquaculture for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources	Fibre, Timber, Ornamental, Biochemical	Raw materials; Medicinal resources	
	Wood provisioning services	Fibers and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources		Raw materials	Timber
		Cultivated plants (incl. fungi, algae) grown as a source of energy	Energy		Raw materials	Fuel wood and charcoal
		Fibers and other materials from wild plants for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources		Raw materials	Fibers
	Wild fish and other natural aquatic products provisioning services	Wild plants (terrestrial and aquatic, incl. fungi, algae) used for nutrition	Food and feed	Food	Food	Plants / vegetable food
		Fibers and other materials from wild plants for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources	Fibre, Timber, Ornamental, Biochemical	Raw materials	Fibers
		Wild plants (terrestrial and aquatic, incl. fungi, algae) used as a source of energy	Energy		Raw materials; Medicinal resources	
		Wild animals (terrestrial and aquatic) used for nutritional purposes	Food and feed	Food	Food	Fish
		Fibers and other materials from wild animals for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources	Fibre, Timber, Ornamental, Biochemical	Raw materials; Medicinal resources	
		Wild animals (terrestrial and aquatic) used as a source of energy	Energy		Raw materials; Medicinal resources	
	Wild animals, plants and other biomass provisioning services	Fibers and other materials from wild plants for direct use or processing (excl. genetic materials)	Materials and assistance, Medicinal, biochemical and genetic resources		Raw materials	Fibers
		Wild plants (terrestrial and aquatic, incl. fungi, algae) used as a source of energy	Energy		Raw materials	Fuel wood and charcoal
		Wild animals (terrestrial and aquatic) used for nutritional purposes	Food and feed	Food	Food	Meat
		Fibers and other materials from wild animals for direct use or processing (excl. genetic materials)	Materials and assistance	Fibre, Timber, Ornamental, Biochemical	Raw materials	Fibers
			Medicinal, biochemical and genetic resources			
		Wild animals (terrestrial and aquatic) used as a source of energy	Energy			
		Wild plants (terrestrial and aquatic, incl.fungi, algae) used for nutrition	Food and feed	Food	Food	Plants / vegetable food
Genetic material services		Seeds, spores and other plant materials collected for maintaining or establishing a population	Habitat creation and maintenance	Genetic materials	Genetic Resources	Plant genetic resources
			Materials and assistance			
			Medicinal, biochemical and genetic resources			
		Higher and lower plants (whole organisms) used to breed new strains or varieties	Medicinal, biochemical and genetic resources			
		Individual genes extracted from higher and lower plants for the design and construction of new biological entities	Medicinal, biochemical and genetic resources			
		Animal material collected for the purposes of maintaining or establishing a population	Habitat creation and maintenance,			Animal genetic resources
			Materials and assistance			

		Medicinal, biochemical and genetic resources			
	Wild animals (whole organisms) used to breed new strains or varieties	Medicinal, biochemical and genetic resources			
	Individual genes extracted from organisms for the design and construction of new biological entities	Medicinal, biochemical and genetic resources			
Water supply	Regulation of the chemical condition of freshwaters by living processes	Regulation of freshwater and coastal water quality	Fresh water	Waste treatment	Water purification
	Surface water for drinking	Not assigned	No equivalent	Water	Drinking water
	Surface water used as a material (non-drinking purposes)	Not assigned	No equivalent	Water	Industrial water
					Irrigation water
	Freshwater surface water used as an energy source	Not assigned	No equivalent	No equivalent	
	Coastal and marine water used as energy source	Not assigned	No equivalent	No equivalent	
Other provisioning services	Animals reared for nutritional purposes	Food and feed	Food	Food	Fish
					Meat
	Fibers and other materials from reared animals for direct use or processing (excl. genetic materials)	Materials and assistance	Fiber, Timber, Ornamental, Biochemical		
		Medicinal, biochemical and genetic resources			
	Animals reared to provide energy (incl. mechanical)	Energy			
	Animals reared by in-situ aquaculture as an energy source				
				Raw materials	Sand, rock, gravel

What is apparent from the cross-comparison table is that ecosystem services classification systems have many overlaps as well as different levels of detail in their breakdown of certain ecosystem services. Overall the classification of CICES is the most detailed among the reviewed systems. Moreover, each ecosystem service may encompass a wider or narrower range of ecosystem services according to its definition.

The ecosystem services classification system that is selected for the Envision review is the UN SEEA EA, as it is one of the most lately updated frameworks. SEEA EA has been built upon previous frameworks thus incorporates their principles, as well as has supported the updates of other systems, as in the case of TEEB. Moreover:

- NESCS has a structure that does not provide a specific list of ecosystem services to serve as a 'checklist' and was not part of the cross-comparison of systems.
- Along with TEEB, IPBES and CICES have significantly expanded work on ecosystem services as first performed by MA and addressed overlaps in definitions of ecosystem services (mainly in the case of supporting services)

2.3. Identification of climate change-relevant ecosystem services

Table 29: UN SEEA-EA Reference list of ecosystem services and relevance to climate change and infrastructure projects

SEEA	SEEA (Subtypes)	Description	Climate change relevance	Infrastructure project-relevance
Global climate regulation services (final ecosystem service)		Regulation of the chemical composition of the atmosphere and oceans that affect global climate through the **accumulation and retention of carbon and other GHG** (e.g., methane) in ecosystems and the ability of ecosystems to remove carbon from the atmosphere.	**mitigation**	**yes**
Rainfall pattern regulation services (at sub-continental scale) (final or intermediate service)		Ecosystem contributions of vegetation, in particular forests, in maintaining rainfall patterns through evapotranspiration at the sub-continental scale. Forests and other vegetation recycle moisture back to the atmosphere where it is available for the generation of rainfall. Rainfall in interior parts of continents fully depends upon this recycling.	**adaptation**	**yes**
Local (micro and meso) climate regulation services (final or intermediate service)		Regulation of ambient atmospheric conditions (including micro and mesoscale climates) through the presence of vegetation that improves the living conditions for people and supports economic production. Examples include the evaporative cooling provided by urban trees ('green space'), the role of urban water bodies ('blue space') and the contribution of trees in providing shade for humans and livestock.	**adaptation**	**yes**

Air filtration services (final service)		Filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, that mitigate the harmful effects of the pollutants.		**yes**
Soil quality regulation services (intermediate service)		Decomposition of organic and inorganic materials and to the fertility and characteristics of soils, e.g., for input to biomass production.	**adaptation**	**yes**
Soil and sediment retention services	**Soil erosion control services** (final or intermediate service)	Stabilizing effects of vegetation that reduce the loss of soil (and sediment) and support e.g., agricultural activity, water supply).	**adaptation**	**yes**
	Landslide mitigation (final service)	Stabilizing effects of vegetation that mitigates or prevents potential damage to human health and safety and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil and rock.	**adaptation**	**yes**
Solid waste remediation (final or intermediate service)		Transformation of organic or inorganic substances, through the action of micro-organisms, algae, plants and animals that mitigates their harmful effects.	**mitigation**	**yes**
Water purification services (water quality amelioration) (final or intermediate service)	**Retention and breakdown of nutrients**	Restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health.	**Adaptation**	**yes**
	Retention and breakdown of other pollutants			**yes**
Water flow regulation services	**Baseline flow maintenance services** (final or intermediate service)	Regulation of river flows and groundwater and lake water tables, derived from the ability of ecosystems to absorb and store water, and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water.	**Adaptation**	**yes**
	Peak flow mitigation services (final service)	Regulation of river flows and groundwater and lake water tables, derived from the ability of ecosystems to absorb and store water, and hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection.	**adaptation**	**yes**
Flood mitigation services	**Coastal protection services** (final service)	Contributions of linear elements in the seascape, for instance coral reefs, sand banks, dunes or mangrove ecosystems along the shore, in protecting the shore and thus mitigating the impacts of tidal surges or storms on local communities.	**adaptation**	**yes**
	River flood mitigation services (final service)	Contributions of riparian vegetation which provides structure and a physical barrier to high water levels and thus mitigates the impacts of floods on local communities. River flood mitigation services will be supplied together with peak flow mitigation services in providing the benefit of flood protection.	**adaptation**	**yes**
Storm mitigation services (final service)		Contributions of vegetation including linear elements, in mitigating the impacts of wind, sand and other storms (other than water related events) on local communities.	**adaptation**	**yes**
Noise attenuation		Reduction in the impact of noise on people that	**Mitigation**	**yes**

services (final service)		mitigates its harmful or stressful effects.	**action projects trade-off**	
Pollination services (final or intermediate service)		Fertilization of crops by wild pollinators that maintains or increases the abundance and/or diversity of other species.	**adaptation**	**yes**
Biological control services	**Pest control services** (final or intermediate service)	Reduction in the incidence of species that may prevent or reduce the effects of pests on biomass production processes or other economic and human activity.	**adaptation**	**yes**
	Disease control services (final service)	Reduction in the incidence of species that may prevent or reduce the effects of species on human health.		
Nursery population and habitat maintenance services (final or intermediate service)		Contributions necessary for sustaining populations of species either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service may input to a number of different final ecosystem services incl. biomass provision.	**adaptation**	
Biomass provisioning services	**Crop provisioning services** (final service)	Growth of cultivated plants that are harvested by economic units for various uses including food and fiber production, fodder and energy.	**adaptation**	**yes**
	Grazed biomass provisioning services (final or intermediate service)	Growth of grazed biomass that is an input to the growth of cultivated livestock.		
	Livestock provisioning services (final service)	Growth of cultivated livestock and livestock products (e.g., meat, milk, eggs, wool, leather), that are used by economic units for various uses, primarily food production. TEEB includes fertilizer (livestock manure) which is infrastructure relevant.	**mitigation**	**yes**
	Aquaculture provisioning services (final service)	Growth of animals and plants (e.g. fish, shellfish, seaweed) in aquaculture facilities that are harvested by economic units for various uses. (e.g. plants cultivated by in- situ aquaculture grown as an energy source)		
	Wood provisioning services (final service)	Growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy.	**adaptation**	**yes**
	Wild fish and other natural aquatic products provisioning services (final service)	Growth of fish and other aquatic biomass that are captured in uncultivated production contexts by economic units for various uses, primarily food production.		
	Wild animals, plants and other biomass provisioning services (final service)	Growth of wild animals, plants and other biomass that are captured and harvested in uncultivated production contexts by economic units for various uses. Also aquatic (e.g. algae) used as a source of energy		
Other provisioning services (from TEEB)		Sand, rock, gravel	**adaptation**	**yes**
Genetic material services (intermediate service to		Contributions from all biota (including seed, spore or gamete production) that are used by economic units, e.g. (i) to develop new animal		

biomass provisioning)		and plant breeds; (ii) in gene synthesis; or (iii) in product development directly using genetic material.		
Water supply (final service)		Water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including household consumption	**adaptation**	**yes**
	(From CICES)	CICES includes other water uses such as surface water used as a material (non-drinking purposes)	**adaptation**	**yes**
	(From CICES)	CICES includes other water uses such as freshwater surface water and coastal and marine water used as energy source	**mitigation**	**yes**

It is worth noting that selected additions from TEEB and CICES were made to clarify aspects of ecosystem services, such as in the case of provisioning services and water supply service.

PART 3: IDENTIFIED HIGH-PRIORITY CRITERIA FOR BIODIVERSITY

1. Pressures on biodiversity (or direct drivers of biodiversity loss)

The pressures on biodiversity, or direct drivers of biodiversity change, according to the IPBES are[206]:

Land, freshwater and sea change (area) causes habitat and ecosystem loss, degradation and fragmentation and can lead to the extinction of species and loss of ecosystem functions and related ecosystem services. Land-use change is the leading driver of terrestrial and freshwater biodiversity loss.

Direct Resource exploitation refers to the exploitation of animals, plants and other organisms, as well as natural resources such as timber and water. The rate of resources exploitation often exceeds their capacity for regeneration with ecological consequences including extinction of species, genetic drift (a change in the gene pool of a population) and habitat degradation.

Climate change and its related effects (e.g. changes in temperature, precipitations, and sea level rise) has direct and indirect effects on the distribution of species, their physiology and behavior and on modification of habitats.

Pollution including fertilizers and pesticides, industrial emissions and marine plastic pollution, cause environmental change, such as modifying the physical and chemical state of soil, air and water, resulting in the degradation of ecosystem quality and threats to plant and animal species. Light and noise pollution, which can result from business operations, also impacts biodiversity by modifying species behavior and distribution.

Invasive species, which may be introduced deliberately or accidentally, pose a threat to ecosystems, habitats and native species through their establishment and propagation.

It is worth mentioning that the International Union for Conservation of Nature (IUCN) in its Guidelines for planning and monitoring corporate biodiversity performance[207] introduces subtypes of pressures, as useful for companies, identifying ten types of pressures that can be placed under the five IPBES headings:

[206] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[207] Stephenson, P.J. and Carbone, G. (2021). "Guidelines for planning and monitoring corporate biodiversity performance." Gland, Switzerland: IUCN.

Box 2. Pressures placed on biodiversity

Ten types of anthropogenic pressure are identified in the CMP/IUCN threat categories (version 3) [8] which can be placed under IPBES headings [4] and may be useful for companies defining their pressures.

Changes in the use of land, sea or water

- Residential and commercial development (housing and urban areas, commercial and industrial areas, tourism and recreational areas) – which can be seen as a form of land-use change
- Agriculture (annual and perennial crops, wood and pulp plantations, livestock farming and ranching) and aquaculture (marine and freshwater) – which can be seen as a form of land-use change
- Energy production and mining (oil and gas drilling, mining and quarrying, renewable energy such as solar and wind farms) – which can be seen as a form of land-use change
- Transportation and service corridors (roads and railways, utility and service lines such as electrical/phone wires and aqueducts), shipping lanes including dredging, canals and ship strikes and flight paths) – which can be seen as a form of land-use change

Direct exploitation

- Biological resource use (hunting and collecting animals, gathering plants, logging and wood harvesting, fishing and harvesting aquatic resources)

Climate change

- Climate change and severe weather (ecosystem encroachment such as sea level rise and desertification, changes in geothermal regimes such as ocean acidification and atmospheric CO_2, changes in temperature regimes such as heat waves, cold spells and ice melt, changes in precipitation and hydrological remines such as droughts, changes in the timing of rains and increased flooding, severe and extreme weather events such as thunderstorms, blizzards, hurricanes and dust storms)

Pollution

- Pollution (household sewage and urban waste water, industrial and military effluents, agricultural and forestry effluents, garbage and solid waste, air-borne pollutants such as acid rain, smog or smoke, excess energy such as noise and light emissions)

Invasion of alien species

- Invasive and other problematic species, genes and diseases (invasive non-native alien plants and animals, problematic native plants and animals such as overabundant deer, algae, grass or fish, introduced genetic material such as pesticide resistant crops or genetically-modified insects, pathogens and microbes)

Other pressures

- Natural system modifications (fire and fire suppression, dams and water management/use, other ecosystem modifications such as land reclamation and tree thinning, removing/reducing human maintenance, such as lack of supplementary feeding or indigenous management of ecosystems)
- Human intrusions and disturbance (recreational activities, war and civil unrest, work and other activities such as law enforcement and vandalism).

It is considered as useful for the purposes of the research and relevant to infrastructure projects to take into consideration the IUCN definition of climate change and severe weather pressure and the natural system modification pressure. Therefore, the final list of pressures that will be used in the Envision review is:

- Land, freshwater and sea change
- Direct Resource exploitation
- Climate change and its related impacts (severe weather)

- Pollution (water, air, soil, waste, noise and light pollution)
- Invasive species and other problematic species

2. Change in the State of biodiversity

Change in the state of biodiversity refers to change in the stock of biodiversity resulting from business activities, considering changes relative to a defined baseline/reference state, for the condition and status of three aspects of biodiversity:

- ecosystems
- species
- final ecosystem services[208]

Table 30: Overview of examples of indicators for reporting changes in the state of biodiversity

State of ecosystems	State of species	State of ecosystem services
• Number or percentage of sites in which ecological richness is progressing /stable/ regressing • Ecosystem/habitat cover change, e.g. forest area as a percentage of total land area or tree cover loss(ha) • Ecosystem extent/ connectivity and integrity • Terrestrial acreage disturbed, percentage of impacted area restored • Soil C (tons C/ha) • Net habitat gain	• Species population and abundance • Risk of species extinction • Areas (ha) of critical habitat for species in priority geographical areas • Number of IUCN Red List species and national conservation list species within priority geographical areas • threatened and endangered species fatalities • Number of invasive alien species identified on the organizations' sites/impact areas; • Wildfire fatalities	

3. Biodiversity Dependencies

Dependencies are defined by SBTN as "aspects of nature's contributions to people (ecosystem services) that a person or organization relies on to function, including water flow and quality regulation; regulation of hazards like fires and floods; pollination; carbon sequestration." The impacts of one business or sector on nature can generate significant financial risk for other businesses or sectors through their dependencies on nature. IUCN defines dependency as: "A company depends on an ecosystem service if that service functions as an input or if it enables, enhances or influences environmental conditions required for successful corporate performance."[209]

The UN SEEA reference list of ecosystem services is used as part of the research to define dependencies on biodiversity (See section 2.1.7 in PART 2.2). The climate change-relevant and infrastructure project

[208] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

[209] Stephenson, P.J. and Carbone, G. (2021). "Guidelines for planning and monitoring corporate biodiversity performance." Gland, Switzerland: IUCN.

relevant services have been identified to define a project's potential dependencies on biodiversity. (See Table 36)

4. Linkages of criteria

The above listed categories of criteria are interlinked. The International Union for Conservation of Nature's (IUCN) Guidelines for corporate biodiversity performance illustrates the links between pressures – state of biodiversity- benefits (ecosystem services/ dependencies) – responses. The guidelines use what they call a framework of linked indicators. The framework suggests that "there should be a relationship between the indicators. A change in response is expected to lead to a change in pressure which leads to a change in state of biodiversity which provides more benefits to people, encouraging more responses. According to IUCN the linked indicators "create a more complete picture of how a company's strategies, actions and responses are faring […] therefore can also monitor a company's delivery of its theory of change."

According to IUCN an advantage of the linked indicator framework is that "given that state level indicators generally change slowly and companies may not be able to demonstrate improvements in species, habitats and ecosystem services, pressure and response indicators can demonstrate change and progress and can help companies verify their selection of strategies or adapt them as needed.

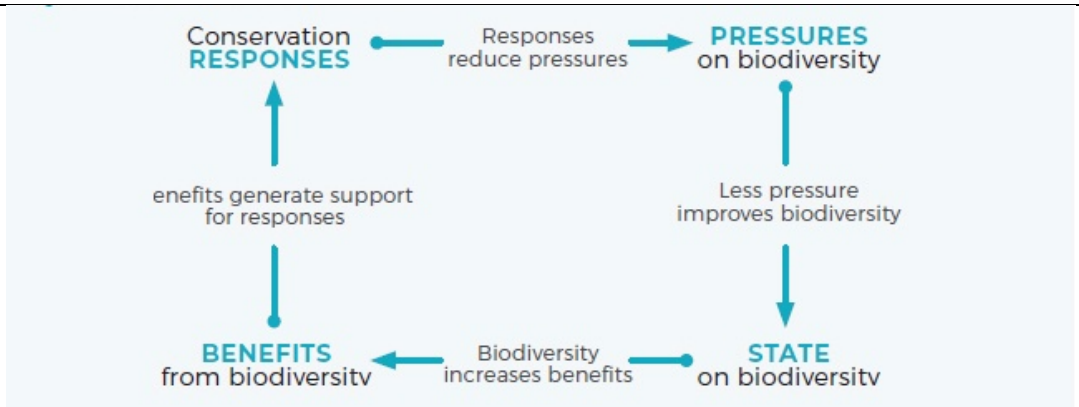


Fig. 23: IUCN's framework of linked indicators

5. Interactions of climate change-biodiversity: towards integrated criteria

As TNFD highlights that an explicit consideration of the interactions between nature and climate-related risk and opportunities is necessary to adequately account for "the synergies between responses to the nature and climate crises" and capture the dual climate and nature benefits of NbS to climate change, as well as the dual climate and nature risks posed by the degradation of natural carbon sinks.[210]

[210] TNFD. (June 2021). "Proposed Technical Scope Recommendations for the TNFD."pg.24.

The interactions between climate change are to a degree resulting to overlaps between the climate change-related criteria and the biodiversity-related criteria. Examples of these overlaps include:

- Climate change is one of the main pressures on biodiversity and action against pressures is a key criterion for evaluation of biodiversity performance.
- The pressure 'Resource exploitation' is overlapping with the 'resource availability' criterion of the climate change-related physical risks.
- Several of the climate change-related performance priority criteria coincide with dependencies on biodiversity, which in turn coincide with final or intermediate ecosystem services, such as:
  - Carbon sequestration and storage (global climate regulation)
  - Decarbonization (biomass provisioning (energy crops) and water supply (freshwater/ marine water as source of energy)
  - Physical asset risk management (rainfall pattern regulation, local climate regulation, soil and sediment retention, water flow regulation, flood mitigation, storm mitigation)
  - Resource availability (water, materials, land) (final ecosystem services: water supply, including potable water and non-potable water as material for processes; biomass provision (wood); as well as intermediate ecosystems services that support the delivery of final services such as pollination, biological control, soil quality regulation, water purification)
  - Supply chain continuity overlaps with pressures on biodiversity along the supply chain that can determine supply disruption (e.g. increased costs of raw materials if biodiversity-intense inputs, for which price has risen due to ecosystem degradation). Pressures along the supply chain are among biodiversity performance criteria.

  The above list is result of the filtering of ecosystem services based on their climate change relevance, which narrowed down UN SEEA's comprehensive list of ecosystem services.

The above overlaps relate to the interactions between climate change and biodiversity and supplement climate change action accounting for biodiversity's contribution.

Table 31: Overlaps between the high-priority criteria for biodiversity and the climate change criteria

Identified high-priority criteria for biodiversity performance			Overlap with climate change criterion
Pressures on biodiversity	**Land, freshwater, sea change**		
	Resource exploitation		**Resource availability risk**
	Pollution	Water	
		Air	
		Soil	
		Waste	Partly with **land availability risk**
		Noise	
		Light	
	Climate change		**all**
	Introduction of invasive species		
Change in the	**Species**		

state of biodiversity	**Ecosystems**			
	Ecosystem services (climate change-relevant) available to the project and/or community	Global climate regulation (including carbon sequestration & storage)		**Carbon capture & storage**
		Rainfall pattern regulation (at sub-continental scale)		**Resource availability risk** (water)
		Local (micro and meso) climate regulation		**Energy efficiency**
		Air filtration		
		Soil quality regulation		
		Soil and sediment retention	Soil erosion control	
			Landslide mitigation	**Physical asset risk**
		Solid waste remediation		
		Water purification (water quality amelioration)	Retention and breakdown of nutrients	
			Retention and breakdown of other pollutants	
		Water flow regulation	Baseline flow maintenance	
			Peak flow mitigation	**Physical asset risk**
		Flood mitigation	Coastal protection	
			River flood mitigation	
		Storm mitigation		**Physical asset risk**
		Noise attenuation		
		Pollination		
		Biological control	Pest control	
			Disease control	
		Nursery population and habitat maintenance		
		Biomass provisioning	Crop provisioning (energy crops)	**De-carbonization**
			Wood provisioning	**Resource availability risk** (materials)
			Wild plants provisioning (terrestrial and aquatic e.g. algae) used as a source of energy	**De-carbonization**
			Livestock provisioning (fertilizer (livestock manure)	
		Other provisioning	Sand, rock, gravel etc.	**Resource availability risk** (materials)
		Water supply	Potable water	**Resource availability risk** (water)
			Non-potable water for use as material to processes, irrigation	
			freshwater surface water and marine water as energy source	**De-carbonization**
Biodiversity management responses	**No net biodiversity loss**	avoid		
		minimize		
		restore		
		offset	Off-site	
	Net		On-site	

	biodiversity gain	renew

Another area of anticipated overlaps is with climate physical opportunities (adaptation). Opportunities of climate action are captured by the seven core principles of resilient systems: resource efficiency (water, materials), durability (of materials), adaptability, redundancy, integration, reflective capacity and inclusivity. Overlaps are expected in these criteria given that the inherent quality of ecosystems to provide multiple benefits represents by-default an opportunity. Moreover, natural systems are resilient systems, unless certain tipping points are crossed, leading to no proper functioning (collapse). What needs to be further explored is biodiversity's relation with the seven principles e.g. if the definitions of these resilient system qualities encompass nature-related qualities? And if another type of opportunity should be added?

Moreover, TNFD recognizes "that accounting for the impacts of climate change on nature loss and the impacts of nature loss on climate change represents an additional layer of complexity within reporting." The added complexity that is required is an area to further explore as part of the research.

6. Biodiversity Management Responses for No Net Loss and Net Biodiversity Gain

Alignment with global nature positive targets requires initially achieving 'no net loss' of biodiversity and eventually 'net gain'. No net loss and net gain are already existing measures of biodiversity as for example in GRESB with its "net habitat gain" indicator.

The objective of "no net loss" targets are based on the aspiration to compensate for unavoidable biodiversity loss, most commonly due to impacts of infrastructure and land-use change, with balanced gains in biodiversity elsewhere, for example through ecosystem restoration or improved management practices.[211]

Biodiversity net gain (or net positive) is a quantitative, stepwise process that is applied to a project and aims for biodiversity to be left in a better state than beforehand. In other words, the impacts on biodiversity caused by the project are outweighed by the actions taken to avoid and reduce such impacts, rehabilitate affected species/ecosystems and offset any residual impacts. [212] It provides clear, quantifiable outcomes for biodiversity with a robust evidence-based suite of tools which allows clear reporting and benchmarking. [213]

Both no net loss and biodiversity net gain follow the mitigation hierarchy, a four-step prioritization tool designed to result in wins for both biodiversity and development. The four steps are as follows[214]:

Avoidance

[211] IPBES- IPCC

[212] NPI Alliance (2015). Net Positive Impact for biodiversity: The conservation case. Gland, Switzerland: IUCN.

[213] Homfray, L. and Tom Butterworth (WSP). (December 2017). "How developers enhance the environment: Introducing Biodiversity Net Gain.

[214] Homfray, L. and Tom Butterworth (WSP). (December 2017). "How developers enhance the environment: Introducing Biodiversity Net Gain.

- Measures taken to avoid creating impacts from the start. For example, changing the location of the development.

Minimization

- Measures taken to reduce the duration, intensity, extent and/or likelihood of impacts that cannot be avoided.

On-site Restoration/ Rehabilitation

- Measures taken to improve degraded ecosystems following exposure to impacts which cannot be completely avoided or minimized.

Offset (off-site compensation)

- Measures taken to compensate for any residual, adverse impacts after full implementation of the previous three steps of the Mitigation Hierarchy.

Following the first three steps alone – avoidance, minimization and onsite rehabilitation/restoration - could be enough to not only reduce the impacts on biodiversity but could also result in a net gain for biodiversity. However, after these three steps have been carefully considered, a "biodiversity offset" may still be required. Biodiversity offsets are a form of offsite compensation whereby a habitat which has been disturbed is recreated elsewhere. Offsets are designed to compensate for significant adverse effects to biodiversity and aim to achieve at least no net loss but preferably a net gain to biodiversity. Using a biodiversity offset is a last resort for any developer and is only considered after all steps of the Mitigation Hierarchy have been applied to a development.[215]

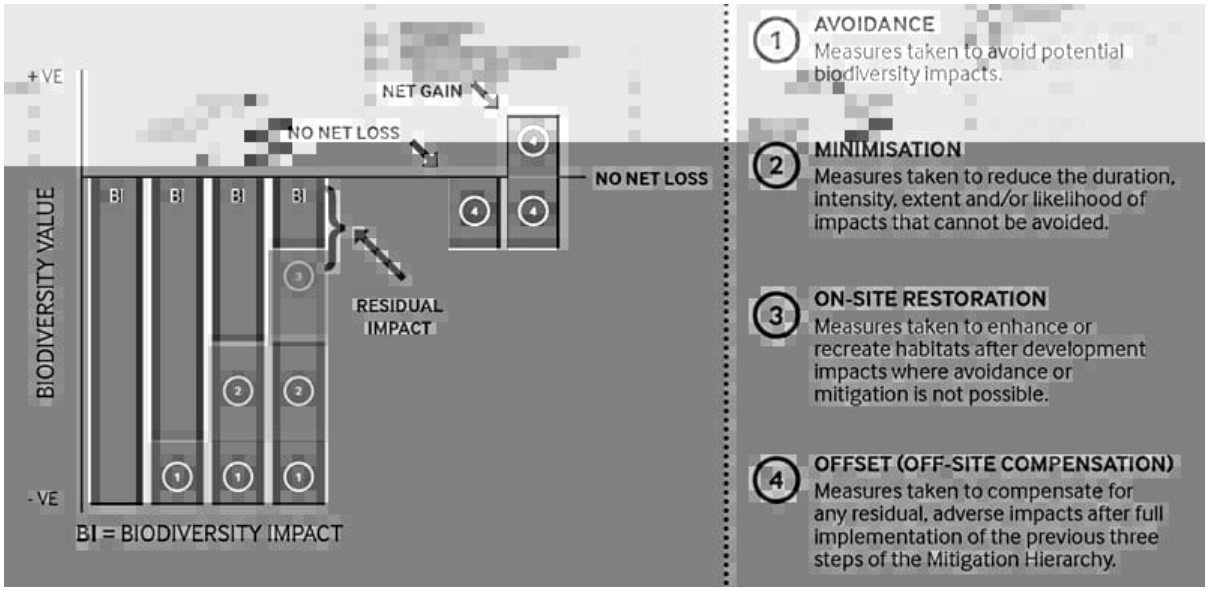


Fig. 24: The Mitigation Hierarchy as illustrated in a graph that demonstrates how Biodiversity net gain can be achieved[216]

The mitigation hierarchy is a well-established and widely used approach as part of Environmental Impact Assessments (EIAs).

[215] Homfray, L. and Tom Butterworth (WSP). (December 2017). "How developers enhance the environment: Introducing Biodiversity Net Gain.

[216] https://www.rpsgroup.com/services/environment/ecology/expertise/biodiversity-net-gain/

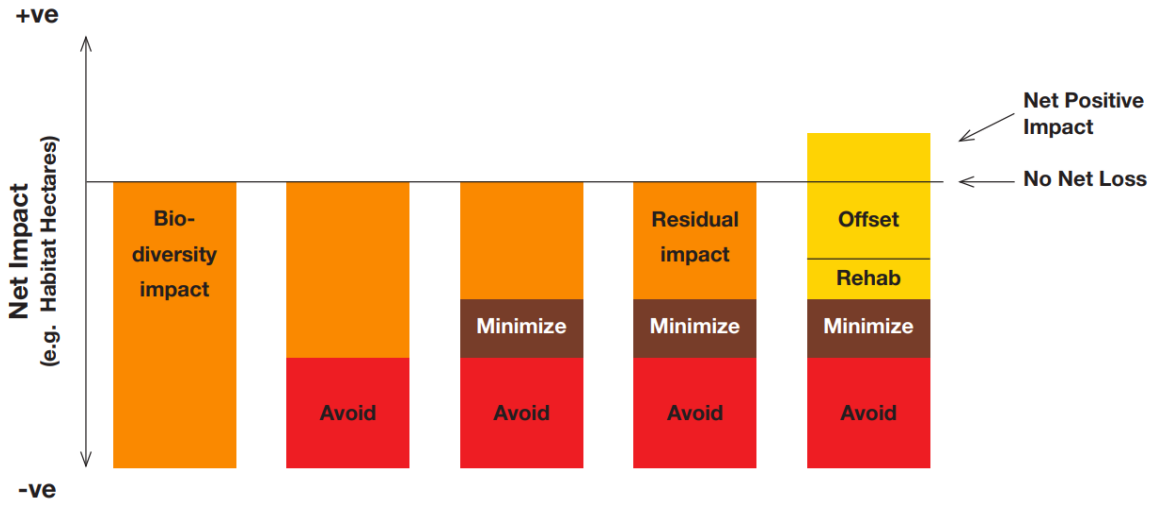


Fig.25: The Mitigation Hierarchy as illustrated in IUCN's paper of 2015 "Net Positive Impact on biodiversity: The conservation case."[217]

Mitigation hierarchies have been used for over a century in natural resource management[218] and its prioritized steps aim to the best outcomes for people and nature. Compensation mechanisms are more prevalent in biodiversity/nature and climate action-frameworks. Building on mitigation offsets for wetlands and endangered species habitat, the biodiversity-conservation mitigation hierarchy was expanded in 2012 with a publication from UN Global Compact and IUCN presenting a corporate action framework at Rio +20 and the International Finance Corporation's Performance Standard 6 for clients to manage environmental and social risk (complemented by World Bank's standard updated in June 2019). These guides focus at a project level, therefore the new globally agreed goals on "no net loss of ecosystem extent and condition" introduces the need to explore what implementing the mitigation hierarchy means at all scales: national, regional, project, and company.[219]

A recent addition to the mitigation hierarchy management approach is the development of the Conservation hierarchy.

The Conservation Hierarchy is founded on the mitigation hierarchy and expands it in two key ways to address past, indirect and diffuse negative impacts on biodiversity beyond the direct impact mitigation:[220]

[217] NPI Alliance (2015). Net Positive Impact for biodiversity: The conservation case. Gland, Switzerland: IUCN.

[218] Mitigation hierarchies exist for biodiversity, waste, energy, carbon, food waste and are adapted for the system they are applied. (source: Stevenson, M. and Weber, C. (April 2020). "WWF Discussion paper: Mitigation hierarchies."

[219] Stevenson, M. and Weber, C. (April 2020). "WWF Discussion paper: Mitigation hierarchies."

[220] Conservation Hierarchy Programme. "What is the mitigation & conservation hierarchy? https://conservationhierarchy.org/what-is-conservation-hierarchy/#:~:text=The%20Mitigation%20and%20Conservation%20hierarchy,contribute%20to%20overarching%20biodiversity%20goals.

1. It can be used by sectors, and for impacts, where the mitigation hierarchy has not yet been widely applied, because the impacts are geographically dispersed through long, complex value chains, e.g. in natural resource exploitation.
2. It adds a conservation element that goes beyond mitigating impacts, to encompass historical, systemic and non-attributable biodiversity loss in the same framework as actions to mitigate specific impacts.[221] While mitigation hierarchy considers impacts **reactively**, the conservation approach considers them **proactively**.[222] It additionally allows for the proactive consideration of conservation actions, such as protected area expansion or habitat restoration.

The conservation hierarchy outlines 4 steps: refrain, reduce, restore and renew which can be implemented via two pathways: the mitigation hierarchy, for mitigating future negative impacts, and the conservation hierarchy, for delivering additional conservation potential. Therefore, it is suggested to be used in parallel with the mitigation hierarchy.

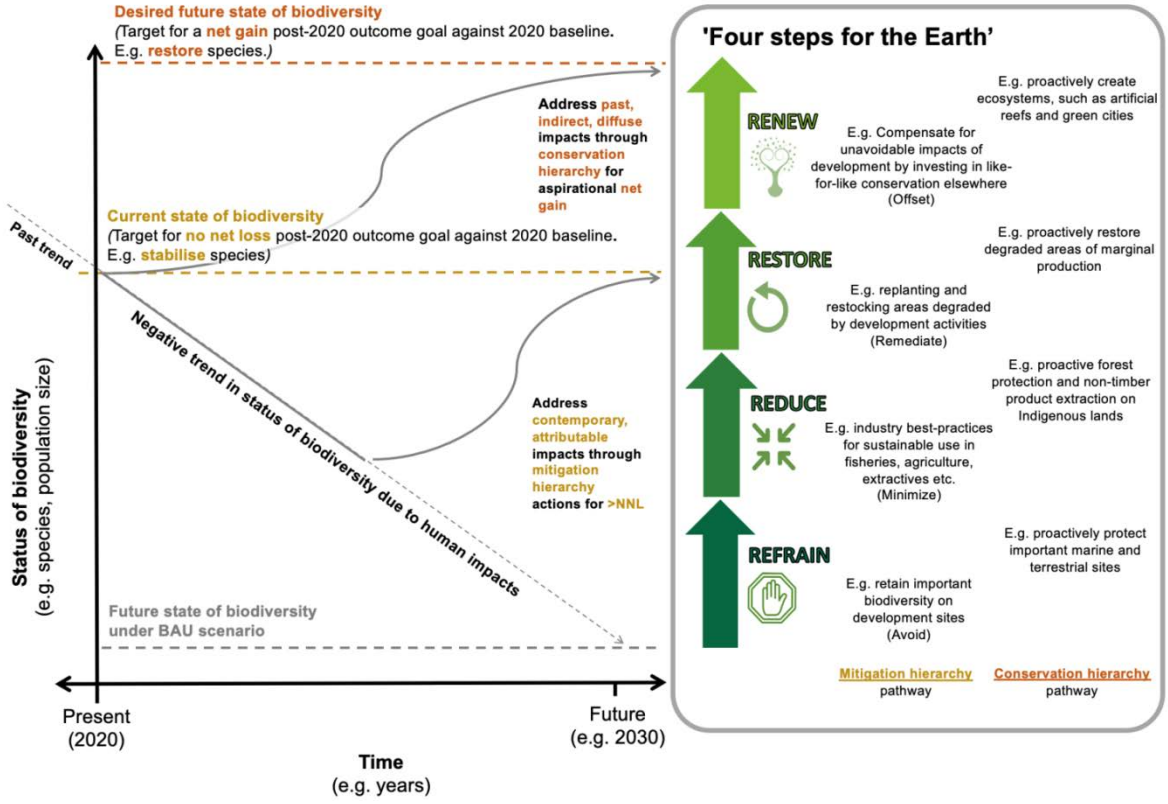


Fig. 26: The four steps of the conservation hierarchy[223]

[221] Conservation Hierarchy Programme. "What is the mitigation & conservation hierarchy?"

[222] Sinclair, S. et al. "The conservation hierarchy: Underpinning the Post-2020 Biodiversity Framework." Paper in CDB website.

[223] Conservation Hierarchy Programme. "What is the mitigation & conservation hierarchy?"

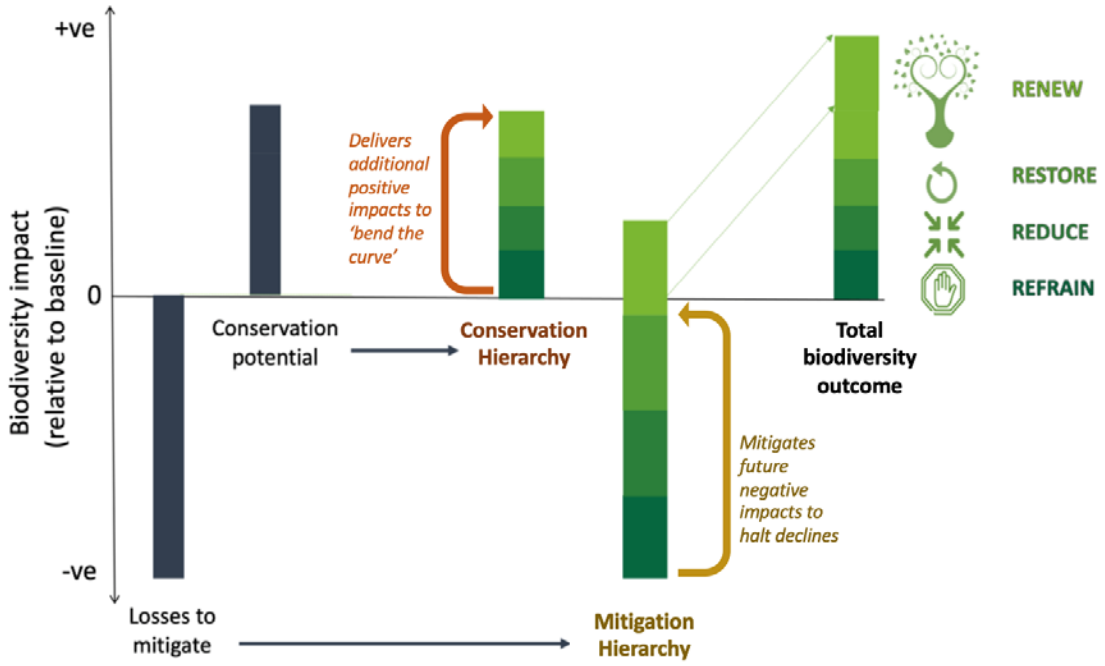


Fig.27: The relationship between the mitigation and conservation hierarchies[224]

	The Reactive Impact Mitigation Hierarchy	The Proactive Conservation Hierarchy
Avoid	Retain woodland patches on project site	Identify areas for protected area expansion
Minimise	Reduce pollutant runoff	Collectively manage polluters to prevent habitat degredation
Restore	Regenerate habitat impacted during construction	Actively restore degraded habitat areas
Offset	Restore and protect habitat offsite	Fund conservation activities in other nations

Fig. 28: Examples of how the mitigation hierarchy considers impacts reactively while the conservation hierarchy considers them proactively[225]

[224] Conservation Hierarchy Programme. "What is the mitigation & conservation hierarchy?"
[225] Sinclair, S. et al. "The conservation hierarchy: Underpinning the Post-2020 Biodiversity Framework."

The mitigation-conservation hierarchy is gaining popularity among the ESG systems with CDSB and SBTN, referring to it as part of their guidance on management responses to biodiversity loss. The CDB and the IUCN have also adopted this impact and risk management approach. [226,227]

This criterion represents a priority for management and mitigation responses and actions to prevent or reduce biodiversity loss, the need for alignment with important global agreements target setting such as the SDGs and United Nations (UN) CBD post-2020 biodiversity framework or national and regional regulations and goals, e.g. EU Biodiversity Strategy for 2030, the Leaders Pledge for Nature, the Nature Compact signed by G7 leaders, National Biodiversity Strategy and Action Plans (NBSAPs), or sectoral initiatives and voluntary commitment initiatives such as the Science-based Targets for Nature.[228]

It is worth mentioning that the biodiversity management responses are relevant to and should aim to address all potential pressures on biodiversity. All types of pressures should be managed for a net negative (no net loss) or net positive (net gain) change in the state of biodiversity and by extension to ecosystem services delivery. Depending on the management response adopted there is an expected corresponding result in the state of biodiversity and ecosystem services, as shown in the graph below.

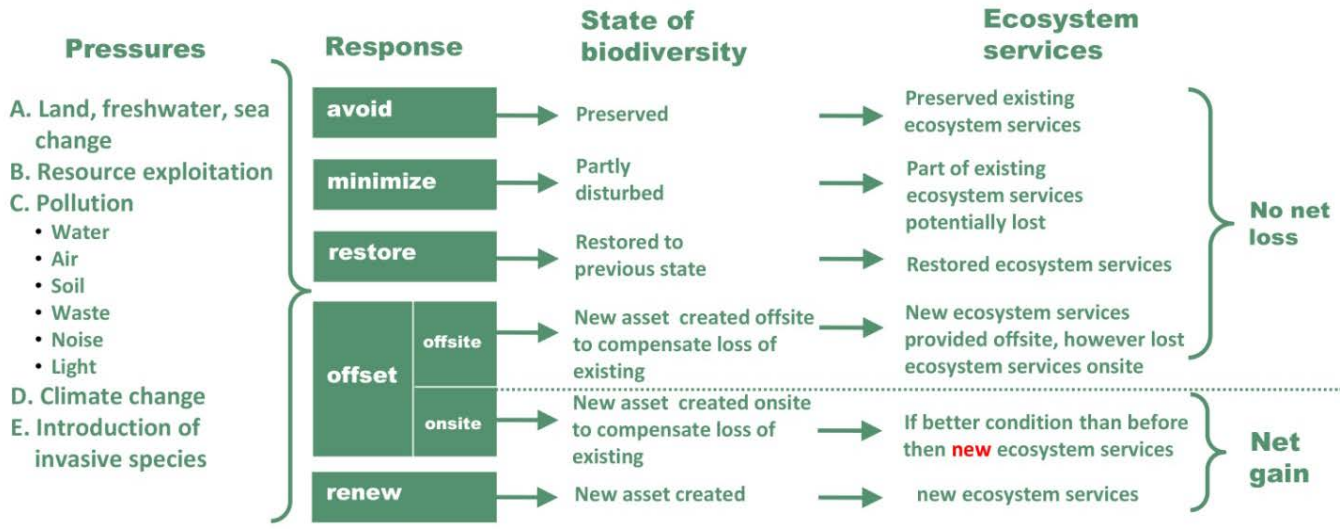


Fig. 29: Management responses through the mitigation hierarchy for all types of pressures on biodiversity. (graph by author)

[226] NPI Alliance (2015). Net Positive Impact for biodiversity: The conservation case. Gland, Switzerland: IUCN. https://portals.iucn.org/library/node/45847

[227] Sinclair, S. et al. "The conservation hierarchy: Underpinning the Post-2020 Biodiversity Framework." Paper in CDB website.

[228] CDSB. (October 2021). Application guidance for biodiversity-related disclosures: Draft application guidance for consultation.

PART 4: ENVISION REVIEW

1. METHODOLOGY FOR REVIEW

1.1. Research questions for the Envision Review

- Does the Envision framework account for the risk of impact on biodiversity due to climate change as part of its climate-related risk assessment?
- Which ecosystem services are captured by Envision credits?
- Which credits implicitly refer to ecosystem services as project dependencies?
- Which ecosystem types are captured by Envision?
- Climate change mitigation- focused review: Does Envision assess and/or guide for the conservation, enhancement or avoided impact on nature's carbon capture and storage capacity?
- Review based on priorities as set for tackling biodiversity and climate twin crises together.
- Which credits refer to conservation, restoration, or enhancement of ecosystems and by extension to provision of ecosystem services in the long-term?
- Classification of Envision Natural World category credits based on if they refer to conservation, restoration or enhancement? Moreover, in the case of conservation or restoration and enhancement is the carbon storage potential also included in evaluating factors?
- According to the IPBES-IPCC report, in a world increasingly affected by climate change, maintaining biodiversity relies on enhanced and well-targeted conservation efforts, coordinated with and supported by strong adaptation and innovation efforts. Does that mean that in conservation credits climate change adaptation should be included? Or that climate change adaptation credits should include biodiversity adaptation?
- Which credits capture the potential of NbS?
- Should criteria be more aggressive given the current biodiversity crisis?

1.2. Approach to integrated climate-biodiversity criteria

The 2020-21 ZHP Research identified a set of priority criteria for assessing infrastructure projects climate change-related performance. The current literature review and analysis of ESG and Ecosystem services classification systems identified priority criteria for assessing biodiversity-related performance. The two types of identified criteria will collectively assess integrated climate-biodiversity action.

However, links and overlaps between climate change and biodiversity have been identified. To avoid the duplication of criteria, the biodiversity performance priority criteria have to be examined against the climate change performance priority criteria to identify overlaps. Examples of these overlaps have been described in a previous section. (See Part 3, Section 6: Interactions climate change-biodiversity: towards integrated criteria).

Once the shared criteria for biodiversity and climate change are identified, the overall list of criteria will be enhanced with those that are biodiversity performance-specific, to result in a comprehensive set of criteria for integrated performance. Finally, given the extensive scope of biodiversity assessment, it is expected that some criteria will need to be targeted on climate change- and infrastructure project-relevance.

As the review of Envision against climate change criteria has already been performed as part of the 2020-21 ZHP Research, the current review will be performed on biodiversity criteria alone (excluding the shared climate-biodiversity criteria) and as a final step the results of the two separate reviews will be reevaluated and synthesized to represent an integrated climate-biodiversity review.

1.3. Review based on identified biodiversity performance criteria

Envision credits will be reviewed using the identified biodiversity criteria, which aim to capture biodiversity-related risks and opportunities for infrastructure projects.

The identified criteria are:

- Pressures on biodiversity (excluding the shared climate-related criteria 'resource exploitation', 'climate change')
  - Land, freshwater and sea change (area and condition)
  - Pollution (water, waste, air, noise and light pollution)
  - Invasive species and other problematic species
- Change in the state of biodiversity (species, ecosystems, ecosystem services)
- Biodiversity dependencies (climate change- and infrastructure project- relevant ecosystem services):
  - Global climate regulation
  - Rainfall pattern regulation
  - Local (micro and meso climate) regulation
  - Soil quality regulation
  - Soil and sediment retention, including soil erosion control and land mitigation
  - Water purification (water quality amelioration) including retention and breakdown of nutrients and retention and breakdown of other pollutants
  - Water flow regulation, including baseline flow maintenance and peak flow mitigation
  - Flood mitigation, including coastal protection and riverflood mitigation
  - Storm mitigation
  - Biological control (pest control)
  - Biomass provisioning including energy crops and wood provisioning
  - Water supply including supply of potable water, non-potable water used as matetial, water as source of energy)
- Biodiversity management responses in relation to 'no net loss' and 'net gain'

  Includes the 4 prioritized steps of the mitigation hierarchy that mainly address no net loss of biodiversity and adds a fifth step of the conservation hierarchy to support biodiversity net gain through creation of new habitats, expansion of conservation and enhancement in existing ecosystems:
  - Avoid

- Minimize
- Restore
- Offset offsite or onsite or to an adjacent contiguous parcel of equal or higher ecological value
- Renew

All the above criteria apply for a project's full lifecycle. Moreover, there is a need for contextualization of the criteria, location- and activity-specific information to complete the assessment of biodiversity performance.

Table 32: Identified high-priority criteria for biodiversity performance

Assessment of Pressures on biodiversity	Land, freshwater, sea change			
	Resource exploitation			Fully addressed by climate change criteria
	Pollution	Water		
		Air		
		Soil		
		Waste		
		Noise		
		light		
	Climate change			Fully addressed by climate change criteria
	Introduction of invasive species			
Assessment of Change in the state of biodiversity	Species			
	Ecosystems			
	Ecosystem services (climate-relevant available for use by the project or the community)			
Assessment of Dependencies on biodiversity	Ecosystem services (climate-relevant & infrastructure project-relevant used by the project)			
Assessment of Biodiversity management responses	**No net biodiversity loss**	avoid		
		minimize		
		restore		
		offset	Off-site and/or onsite (with like-for-like)	
	Net biodiversity gain		On-site (with better) or on adjacent parcel	
		renew		

1.4. Review against a selected Ecosystem Services classification system (UN SEEA)

The UN SEEA reference list of ecosystem services is used as a checklist, or set of reporting categories against which an analysis of Envision credits will be performed. Objective of this mapping is to identify ecosystem services that are being addressed by the Envision framework. As already described

ecosystem services represent a company's and a project's dependencies on nature. Therefore such mapping supplements the review based on biodiversity performance criteria with a more detailed review of dependencies, which are not comprehensively captured by ESG systems so far.

Though the priority focus of the review is on climate change-related ecosystem services/ dependencies (mainly regulating services and provisioning), the full list of ecosystem services will be used in the Envision review to highlight potential unintended trade-offs in the provision of other services beyond the project's boundary e.g. for the community.

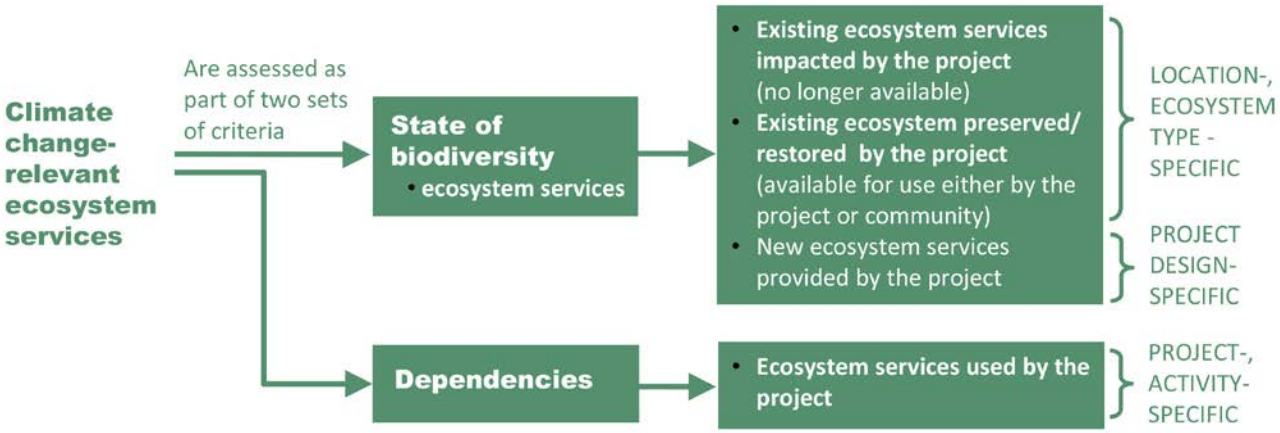


Fig. 30: Two distinct ways that ecosystem services are being assessed as part of the high-priority criteria (graph by author)

This distinction of ecosystem services is aligned with CDSB's approach to the reporting of final ecosystem services (FES). CDSB classifies FES in three types:

- Supply of FES available to the business
- Delivery of FES utilized by the business
- Contributions to wellbeing to both internal and external stakeholders.

The last type of FES extends reporting beyond the project's dependencies to account for the community's dependencies on nature.

Therefore, the list used for the review of how and if Envision assesses change in the state of biodiversity (ecosystem services) is:

Table 33: List of Ecosystem services (climate change- relevant) available to be used by the project and/or community

Ecosystem services (climate change- relevant) available to the project and/or community	Global climate regulation	
	Rainfall pattern regulation (at sub-continental scale)	
	Local (micro and meso) climate regulation	
	Air filtration	
	Soil quality regulation	
	Soil and sediment retention	Soil erosion control
		Landslide mitigation
	Solid waste remediation	
	Water purification	Retention and breakdown of nutrients

	(water quality amelioration)	Retention and breakdown of other pollutants
	Water flow regulation	Baseline flow maintenance
		Peak flow mitigation
	Flood mitigation	Coastal protection
		River flood mitigation
	Storm mitigation	
	Noise attenuation	
	Pollination	
	Biological control	Pest control
	Nursery population and habitat maintenance	
	Biomass provisioning	Crop provisioning (food crops, energy crops)
		Wood provisioning
		Wild plants (terrestrial and aquatic e.g. algae) used as a source of energy
		Livestock provisioning
	Other provisioning services	Sand, rock, gravel etc. (addition from TEEB as infrastructure project relevant)
	Water supply	Potable water
		Non-potable water for use as material to processes, irrigation
		freshwater surface water and coastal and marine water as energy source

For the review of how and if Envision assesses infrastructure projects' dependencies on biodiversity (ecosystem services) the list used is:

Table 34: List of Ecosystem services (climate change- relevant & infrastructure- relevant) used by the project

Ecosystem services (climate change- relevant & infrastructure-relevant) used by the project	Global climate regulation	
	Rainfall pattern regulation (at sub-continental scale)	
	Local (micro and meso) climate regulation	
	Air filtration	
	Soil quality regulation	
	Soil and sediment retention	Soil erosion control
		Landslide mitigation
	Solid waste remediation	
	Water purification (water quality amelioration)	Retention and breakdown of nutrients
		Retention and breakdown of other pollutants
	Water flow regulation	Baseline flow maintenance
		Peak flow mitigation
	Flood mitigation	Coastal protection
		River flood mitigation
	Storm mitigation	
	Noise attenuation	
	Biological control	Pest control
	Biomass provisioning	Crop provisioning (energy crops)
		Wood provisioning
		Wild plants (terrestrial and aquatic e.g. algae) used as a source of energy
		Livestock provisioning (fertilizer (livestock manure)

	Other provisioning services	Sand, rock, gravel etc. (addition from TEEB as infrastructure project relevant)
	Water supply	Potable water
		Non-potable water for use as material to processes, irrigation
		freshwater surface water and coastal and marine water as energy source

2. ENVISION REVIEW BASED ON BIODIVERSITY PERFORMANCE CRITERIA

2.1. Pressures on Biodiversity

The pressures on biodiversity are:

1. Land, freshwater and sea change
2. Direct Resource exploitation
3. Climate change and its related impacts (severe weather)
4. Pollution (water, air, soil, waste, noise and light pollution)
5. Invasive species and other problematic species

The review did not include 'climate change' and 'resource exploitation' pressures as these were fully covered as part of the Envision review based on climate change-related criteria.

Table 35: Envision credits that assess pressures on biodiversity

ENVISION CREDITS	PRESSURES ON BIODIVERSITY											
	LAND, FRESHWATER, SEA CHANGE			RESOURCE EXPLOITATION	POLLUTION						CLIMATE CHANGE	INTRODUCTION OF INVASIVE SPECIES
	land	freshwater	sea		water	air	soil	waste	noise	light		
QL1.4 Minimize Noise & Vibration									■			
QL1.5 Minimize Light Pollution										■		
QL3.2 Preserve Historic & Cultural Resources	■											
QL3.4 Enhance Public Space and Amenities	■											
LD1.4 Pursue Byproduct Synergies	■							■				
LD2.1 Establish a Sustainability Management Plan												
LD2.4 Plan for end-of-life	■							■				
RA1.1 Support Sustainable Procurement Practices												
RA1.2 Use Recycled Materials	■				■		■	■				
RA1.3 Reduce Operational Waste	■				■		■	■				
RA1.4 Reduce Construction Waste	■				■		■	■				
RA1.5 Balance Earthwork On Site							■					■
RA2.3 Use Renewable Energy	■											
NW1.1 Preserve Sites of High Ecological Value	■											
NW1.2 Provide Wetland & Surface Water Buffers		■			■							
NW1.3 Preserve Prime Farmland	■											
NW1.4 Preserve Undeveloped Land	■											
NW2.1 Reclaim Brownfields	■	■			■		■					
NW2.2 Manage Stormwater		■			■		■					
NW2.3 Reduce Pesticide & Fertilizer Impacts					■		■					■
NW2.4 Protect Surface & Groundwater Quality		■			■							

NW3.1 Enhance Functional Habitats												
NW3.2 Enhance Wetland and Surface Water Functions												
NW3.3 Maintain Floodplain Functions												
NW3.4 Control Invasive Species												
NW3.5 Protect Soil Health												
CR1.3 Reduce Air Pollutant Emissions												

As shown in the table above all pressures on biodiversity are assessed by Envision credits.

IDENTIFIED GAP: Pressure 'noise'
Though Credit QL1.4 Minimize Noise & Vibration assesses the project's impacts on noise levels and noise mitigation strategies, the mitigation or compensation strategies are assessed for addressing impact on community (e.g. based on proximity to residential or sensitive population), without reference on noise as a pressure on biodiversity.

2.2. Changes in the state of biodiversity

The assessment of change in the state of biodiversity includes assessment in change of:

- Species
- Ecosystems
- Ecosystem services (climate-relevant available for use by the project or the community)

Table 36: Envision credits that assess change in the state of biodiversity

ENVISION CREDITS	SPECIES	ECOSYSTEMS	ECOSYSTEM SERVICES
RA1.1 Support Sustainable Procurement Practices			Change in the state of ecosystem services will be reviewed in a following paragraph (see review of Envision against UN SEEA EA)
RA1.3 Reduce Operational Waste			
RA1.4 Reduce Construction Waste			
RA1.5 Balance Earthwork On Site			
RA2.3 Use Renewable Energy			
NW1.1 Preserve Sites of High Ecological Value			
NW1.2 Provide Wetland & Surface Water Buffers			
NW1.3 Preserve Prime Farmland			
NW1.4 Preserve Undeveloped Land			
NW2.1 Reclaim Brownfields			
NW2.2 Manage Stormwater			
NW2.3 Reduce Pesticide & Fertilizer Impacts			
NW2.4 Protect Surface & Groundwater Quality			
NW3.1 Enhance Functional Habitats			
NW3.2 Enhance Wetland and Surface Water Functions			
NW3.3 Maintain Floodplain Functions			
NW3.4 Control Invasive Species			
CR2.3 Evaluate Risk and Resilience			

2.3. Dependencies on Biodiversity

The review on project's dependencies on biodiversity focuses on those ecosystem services that are both climate- and infrastructure project relevant.

As expected not all types of infrastructure projects have the same dependencies on biodiversity. These infrastructure project type dependencies will be further reviewed as part of the generic analysis per infrastructure type (transportation, water and energy projects) and the specific project case studies that supplement the research.

Table 37:

ENVISION CREDITS	ECOSYSTEM SERVICES (used by the project)																								
	Global climate regulation	Rainfall pattern regulation	Local (micro and meso) climate regulation	Air filtration	Soil quality regulation	Soil and sediment retention		Solid waste remediation	Water purification		Water flow regulation		Flood mitigation		Storm mitigation	Noise attenuation	Biological control	Nursery population and habitat maintenance	Biomass provisioning			Other	Water supply		
						Soil erosion control	Landslide mitigation		Retention and breakdown of nutrients	Other pollutants	Baseline flow maintenance	Peak flow mitigation	Coastal protection	River flood mitigation			Pest control		Energy crops	wood	Wild plants	Sand rock	Potable water	Non-potable as material	Water as energy source
LD1.4 Pursue Byproduct Synergies								■																■	
RA1.1 Support Sustainable Procurement Practices																									
RA1.3 Reduce Operational Waste								■																	
RA1.4 Reduce Construction Waste								■																	
RA1.5 Balance Earthwork On Site					■	■																			
RA2.3 Use Renewable Energy																		■	■						■
RA3.1 Preserve Water Resources		■							■	■													■		
RA3.2 Reduce Operational Water Consumption																							■	■	
RA3.3 Reduce Construction Water Consumption																							■	■	
RA3.4 Monitor Water Systems									■	■													■		
NW1.1 Preserve Sites of High Ecological Value																									
NW1.2 Provide Wetland & Surface Water Buffers		■	■	■		■	■	■	■	■	■	■	■	■	■	■		■					■		
NW1.3 Preserve Prime Farmland																			■						
NW1.4 Preserve Undeveloped Land																									
NW2.1 Reclaim Brownfields					■					■															
NW2.2 Manage Stormwater		■	■			■	■		■	■	■	■	■	■				■					■	■	
NW2.3 Reduce Pesticide & Fertilizer Impacts				■	■	■		■	■								■								
NW2.4 Protect Surface & Groundwater Quality								■	■	■													■		
NW3.1 Enhance Functional Habitats																									
NW3.2 Enhance Wetland and Surface Water Functions									■	■	■	■						■					■		
NW3.3 Maintain Floodplain Functions													■	■											
NW3.4 Control Invasive Species																	■								
NW3.5 Protect Soil Health	■				■	■																			
CR1.1 Reduce Net Embodied Carbon	■																								
CR1.2 Reduce Greenhouse Gas Emissions	■																								
CR1.3 Reduce Air Pollutant Emissions				■																					
CR2.1 Avoid Unsuitable Development						■	■																		
CR2.2 Assess Climate Change Vulnerability		■									■	■	■	■	■								■		
CR2.3 Evaluate Risk and Resilience			■										■	■	■										

2.4. Biodiversity management responses (biodiversity no net loss and net gain)

As already mentioned, the biodiversity 'no net loss' and 'net gain' follow the mitigation hierarchy that is a core strategy in the Envision Guidance '*to discern how to prioritize options or even take the first step toward sustainability',* and one of the strategies that distinguishes the Envision approach:

- Avoidance: Measures taken to avoid creating impacts from the outset
- Minimization: Measures taken to reduce the duration, intensity or extent of impacts that cannot be avoided
- Abatement: Measures taken to rehabilitate degraded ecosystems
- Offsetting: Measures taken to compensate for any residual adverse impacts[229]

The Envision credits in which impact assessment is based on the mitigation hierarchy are shown in the following table. The levels of achievement for these credits are linked with different steps of the hierarchy:

Table 38: Mitigation hierarchy in Envision credits

ENVISION CREDITS	LEVELS OF ACHIEVEMENT				
	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
QL1.4 Minimize Noise pollution				No noise increase	Noise reductions within the surrounding community beyond existing conditions.
QL1.5 Minimize Light Pollution	Light Pollution Reduction	Master Lighting Plan	Eliminating Uplight	Backlight, Uplight, and Glare Reduction	Night Sky Restoration
QL3.2 Preserve Historic & Cultural Resources				Conservation	Restoration of a threatened or degraded resource or results in a resource being added to a protected registry
QL3.3 Enhance Views and Local Character	Value Identification	Alignment With Community Values	Preservation And Enhancement	Connections And Collaboration	Restoring Community Character
QL3.4 Enhance Public Space and Amenities	No Net Loss	Community Involvement	Improvement And Enhancement	Overall Net Benefit (new public resource)	Substantial Restoration of lost, degraded/ unusable or at-risk public space
RA3.1 Preserve Water Resources	Increased Awareness of Watershed Issues	Good Water Resource Management	Wise Water Resource Management (net-zero impact)	Total Water Management (watershed or regional scale)	Positive Impact to the watershed
RA3.2 Reduce Operational Water Consumption	At Least 25% Reduction	At Least 50% Reduction	At Least 75% Reduction	95% Reduction	Water Purification (100% Reduction & water provision)
RA3.3 Reduce Construction Water Consumption	Identify Consumption and Reduction Options	At Least Two Reduction Strategies implemented	At Least Four Reduction Strategies implemented	No Potable Water Consumption	

[229] Envision Manual Version 3, pg. 13.

NW1.1 Preserve Sites of High Ecological Value	Improved siting	Full mitigation	Total avoidance	Habitat protection	Habitat expansion
NW1.2 Provide Wetland & Surface Water Buffers	Buffers	Managed buffers	Mixed buffers	Natural buffers	Buffer restoration
NW1.3 Preserve Prime Farmland		Less than 10% disturbance	Less than 5% disturbance	100% avoidance	Restore productive farmland
NW1.4 Preserve Undeveloped Land	At Least 25% Previously Developed	At Least 50% Previously Developed	At Least 75% Previously Developed	100% Previously Developed	Restore natural areas
NW2.1 Reclaim Brownfields	Reuse former brownfield	Mitigate exposure	Passive remediation	Active remediation	Complete remediation
NW2.2 Manage Stormwater	Detain and treat 100% of the 85th percentile local 24-hour event AND Do not exceed rate or quantity of runoff for the 2-year 24-hour rainfall event	Infiltrate, evapotranspirate, and/or reuse 100% of 85th percentile local 24-hour event. OR detain and treat 150% of 85th percentile 24-hour event. AND Do not exceed rate or quantity of runoff for the 2- and 5-year 24-hour rainfall event	100% of 90th percentile local 24-hour event. OR detain and treat 150% of 90th percentile 24-hour event. AND Do not exceed rate or quantity of runoff for the 2-, 5-, and 10-year 24-hour rainfall event	100% of 95th percentile local 24-hour event OR detain and treat more than 150% of 95th percentile 24-hour event AND Do not exceed rate or quantity of runoff for the 2-, 5-, 10-, 25-, and 50-year 24-hour rainfall event	The project manages or treats stormwater from other sites, OR returns the site to a predevelopment hydrological condition.
NW2.3 Reduce Pesticide & Fertilizer Impacts	Application management	Less Pesticide Or Fertilizer		No Pesticide Or Fertilizer Use	Pesticide Or Fertilizer Elimination (in sites with prior use)
NW2.4 Protect Surface & Groundwater Quality	New Pathway Avoidance	Community Support	Risk Reduction	Public Reporting	Quality Improvement
NW3.1 Enhance Functional Habitats	Mitigate Impacts on existing habitat functions	Enhance at least one Ecosystem Function	Enhance at least two Ecosystem Functions	Enhance at least three Ecosystem Functions	Restore and create habitats
NW3.2 Enhance Wetland and Surface Water Functions	Enhance One Ecosystem Function	Enhance two Ecosystem Functions	Enhance three Ecosystem Functions	Enhance four Ecosystem Functions	Restore ecosystem function
NW3.3 Maintain Floodplain Functions	75% Avoidance	85% Avoidance	95% Avoidance	Floodplain preservation	Floodplain Restoration
NW3.4 Control Invasive Species	Prevention	Assessment and Prevention	Program Controls	Minor Infestation Control	Major Infestation Control
NW3.5 Protect Soil Health		Restore Soils disturbed during construction	Special Feature Plan	Best Management Practices	Soil Restoration of areas disturbed by previous development
CR1.2 Reduce GreenhouseGas Emissions	At Least 10% Reduction	At Least 25% Reduction	At least 50% Reduction	100% Reduction	Carbon Negative (i.e., sequesters/ removes more CO2e than it produces over the operational life).
CR1.3 Reduce Air Pollutant Emissions	Exceeding Requirements	Ongoing Monitoring	VOC Minimization	Air Pollutant Elimination	Air Quality Improvement
CR2.1 Avoid Unsuitable Development	Alternative Assessment	Risk Mitigation	Lowest Risk Alternative	Unsuitable Development Avoided	Strategic Retreat

It is worth adding that the above credits assess pressures on biodiversity as shown in the table below and in addition through the Envision levels of achievement they assess the management response to those pressures (avoidance, minimization, restoration, offset/compensation and renewal):

Table 39: Mitigation hierarchy in Envision credits in relation with the type of pressure on biodiversity they refer to

Envision Credits	pressure	No net loss					Net gain
		avoid	minimize	restore	offset		renew
					offsite	Onsite	
QL1.4 Minimize Noise & Vibration	Noise pollution	■		■			
QL1.5 Minimize Light Pollution	Light pollution	■	■	■			
QL3.2 Preserve Historic & Cultural Resources	Land change	■		■			■
QL3.3 Enhance Views and Local Character							■
QL3.4 Enhance Public Space & Amenities	Land change	■		■		■	■
RA1.2 Use Recycled Materials	Resource exploitation		■				
RA1.3 Reduce Operational Waste	Waste pollution		■				
RA1.4 Reduce Construction Waste	Waste pollution		■				
RA1.5 Balance Earthwork On Site	Waste pollution & Introduction of invasive species	■	■				
RA3.1 Preserve Water Resources	Resource exploitation	■	■				■
RA3.2 Reduce Operational Water Consumption	Resource exploitation	■	■				■
RA3.3 Reduce Construction Water Consumption	Resource exploitation	■	■				
NW1.1 Preserve Sites of High Ecological Value	Land change	■	■	■	■	■	■
NW1.2 Provide Wetland & Surface Water Buffers	Freshwater change	■	■	■			
NW1.3 Preserve Prime Farmland	Land change	■	■	■	■	■	
NW1.4 Preserve Undeveloped Land	Land change	■	■	■			■
NW2.1 Reclaim Brownfields	Land change & soil/ water pollution			■			■
NW2.2 Manage Stormwater	Water pollution			■			■
NW2.3 Reduce Pesticide & Fertilizer Impacts	Soil and Water pollution	■	■	■			■
NW2.4 Protect Surface & Groundwater Quality	Water pollution	■	■	■			
NW3.1 Enhance Functional Habitats		■	■	■			■
NW3.2 Enhance Wetland and Surface Water Functions				■			
NW3.3 Maintain Floodplain Functions		■	■				
NW3.4 Control Invasive Species	Introduction of invasive species	■					
NW3.5 Protect Soil Health	Soil pollution						
CR1.1 Reduce Net Embodied Carbon	Climate change		■				
CR1.2 Reduce Greenhouse Gas Emissions	Climate change	■	■		■		■
CR1.3 Reduce Air Pollutant Emissions	Air pollution	■	■				■

The listed credits include assessment of 'no net loss' of biodiversity through the **'no net impact'** on biodiversity, **mostly related with the conservative level of achievement**. The biodiversity **'net gain'** is **connected with the Envision 'restorative' level of achievement** in the following credits:

Table 40: Restorative level of performance in credit as an equivalent of 'net gain'

Credit (V3)	Definition of restorative performance per credit[230]
QL3.2 Preserve Historic & Cultural Resources	The project enhances or restores a threatened or degraded historic/cultural resource (natural features included) or results in a historical resource being added to a protected registry.
QL3.3 Enhance Views & Local Character	**Restoring Community Character** The project restores previously lost **or** degraded views or community features OR enhances the community by creating new features of local character. Actions are supported through the stakeholder engagement process.
QL3.4 Enhance Public Space & Amenities	**Substantial Restoration** The project restores lost, degraded/unusable, or at-risk public space or amenities. The public space/amenity is an asset of significance to the local community commensurate with the scope and scale of the project. (e.g. a public park in a neighborhood identified as lacking sufficient park space)
RA3.1 Preserve Water Resources	**Positive Impact** The project makes a direct and significant net-positive improvement to the watershed (in terms of water quantity and availability or water quality. Examples of watershed improvements may include improved water quality, better hydrologic connectivity, or water storage and availability.)
RA3.2 Reduce Operational Water Consumption	**Net positive impact on water use** Design documents demonstrating that the project achieves a 100% reduction in potable water use, using no water or meeting water needs entirely through non-potable sources, and provides an available source of usable water (potable or non-potable) for neighboring projects or communities to offset their own water needs.
NW1.1 Preserve Sites of High Ecological Value	**Habitat Expansion** The project increases the area of high ecological value. This involves the restoration of areas of high ecological value or conservation of surrounding areas, as determined by a licensed or similarly qualified professional.
NW1.2 Provide Wetland & Surface Water Buffers	**Buffer Restoration** The creation of the protective buffers includes returning previously developed or disturbed areas to a natural state. Project teams may alternatively demonstrate the recovery of pre-existing buffer zones that have degraded in quality.
NW1.3 Preserve Prime Farmland	**Restore Productive Farmland** In addition to 100% avoidance, the project includes protecting farmlands for posterity against future disturbance, or restoring previously developed areas to a contiguous, functional, and productive farmland state.
NW1.4 Preserve Undeveloped Land	**Restore Natural Areas** Return developed areas to a condition that supports, or could support, open space, habitat, or natural hydrology.
NW2.1 Reclaim Brownfields	**Complete remediation** Active remediation or a combination of active and passive remediation, is performed to restore the entirety of site soils and/or groundwater back to regional background or unrestricted use levels. AND The Brownfield site is closed/ deregulated by regulators, or is in the process of closing and has a long-term site management, monitoring, and inspection plan.
NW2.2 Manage Stormwater	The project manages or treats stormwater from other sites OR returns the site to a predevelopment hydrological condition.
NW2.3 Reduce Pesticide & Fertilizer Impacts	**Pesticide or Fertilizer Elimination** Landscaping is designed with plant species that do not require pesticides or fertilizers. This

[230] Envision Manual Version 3

	includes eliminating the need for pesticides and/or fertilizers on sites with prior use of pesticides or fertilizers.
NW2.4 Protect Surface & Groundwater Quality	**Quality Improvement** The project improves surface water and/or groundwater quality beyond existing conditions.
NW3.1 Enhance Functional Habitats	**Restore And Create Habitats** The project returns developed land to natural habitat, or sets aside existing habitat for permanent conservation and protection. Includes new connections provided between habitats and their appropriateness for the local wildlife, and/or removal of existing barriers to movement and habitat connectivity.
NW3.2 Enhance Wetland & Surface Water Functions	**Restore Ecosystem Function** Actively protect four ecosystem functions. • Hydrologic Connection • Water Quality • Aquatic/Riparian Habitat • Sediment Transport/Sedimentation In addition to protecting all existing wetland and surface water functions, the project can demonstrate it has restored at least one previously degraded wetlands and/or surface water function. (includes restoration of habitat connectivity)
NW3.3 Maintain Floodplain Functions	**Floodplain Restoration** The project avoids developing any existing natural/vegetated zones within the floodplain. Structures are removed from the floodplain, or previously developed areas are restored to natural/vegetated zones in order to improve floodplain functions.
NW3.4 Control Invasive Species	Ongoing control, containment or suppression plans for major infestations of invasive species
NW3.5 Protect Soil Health	**Soil Restoration** All areas disturbed by previous development and planned as vegetated areas have been restored for appropriate soil type, structure, and function to support plant and tree growth.

As shown in the above table all Natural World credits are included.

Overall Envision assesses biodiversity management responses based on the Mitigation hierarchy and therefore is aligned with 'no net negative' and 'net positive' targets, and priority on preservation, restoration and enhancement of ecosystems, especially in higher levels of achievement.

IDENTIFIED GAPS

1. **Though Envision refers to 'no net loss' or 'overall net benefit' or 'positive impact' or 'habitat expansion', there is no consistent use of terms in all relevant cases.**
   Potential alignment of Envision terminology with 'no net loss' and 'net biodiversity gain' terms as they represent current global targets for biodiversity is recommended.

2. **Carbon sequestration potential and carbon storage capacity are not among the factors defining high value ecosystems in credit NW1.1 Preserve Sites of High Ecological value**.
   The preservation and restoration of carbon rich ecosystems should be a top priority from a joint climate-biodiversity perspective, according to the IPCC-IPBES. Soil carbon/ net primary production should be among the factors for defining high ecological value.

3. ENVISION REVIEW AGAINST AN ECOSYSTEM SERVICES CLASSIFICATION SYSTEM

This section explores which ecosystem services are explicitly or implicitly referenced in Envision credits and which are directly or indirectly related with the impact assessed by each credit. In the below table that summarizes the analysis performed, the complete set of ecosystem services as listed in UN SEEA Reference List are included and not only the climate change related ecosystem services as in previous parts of the analysis.

Table 41: Envision credits that assess/refer to ecosystem services provision (for the project and/or the community)

ENVISION CREDITS	Global climate regulation	Rainfall pattern regulation	Local (micro and meso) climate regulation	Air filtration	Soil quality regulation	Soil and sediment retention		Solid waste remediation	Water purification		Water flow regulation		Flood mitigation		Storm mitigation	Noise attenuation	Pollination	Biological control	Nursery population and habitat maintenance	Biomass provisioning						Genetic material	Other provisioning	Water supply			Cultural services				
						Soil erosion control	Landslide mitigation		Retention and breakdown of nutrients	Retention and breakdown of other pollutants	Baseline flow maintenance	Peak flow mitigation	Coastal protection	River flood mitigation				Pest control		Crop (food, fiber, energy)	Grazed biomass	livestock	wood	Aquatic products	Wild plants		Sand rock	Potable water	Non-potable water as material	water as energy source	Recreation-related	Visual amenity	Education, scientific and research	Spiritual, artistic and symbolic	Ecosystem and species appreciation
QL3.2 Preserve Historic & Cultural Resources																																	
QL3.3 Enhance Views & Local Character																																	
QL3.4 Enhance Public Space & Amenities																																	
LD1.4 Pursue Byproduct Synergies								■																			■	■					
LD2.4 Plan for End-of-life																																	
RA1.1 Support Sustainable Procurement Practices																																	
RA1.3 Reduce Operational Waste								■																									
RA1.4 Reduce Construction Waste								■																									
RA1.5 Balance Earthwork On Site					■	■																											
RA2.3 Use Renewable Energy																			■	■													
RA3.1 Preserve Water Resources		■							■																		■	■					
RA3.2 Reduce Operational Water Consumption																											■						
RA3.3 Reduce Construction Water Consumption																											■						
RA3.4 Monitor Water Systems									■	■																	■						
NW1.1 Preserve Sites of High Ecological Value	■	■	■	■	■	■			■	■	■	■	■	■	■	■										■				■	■	■	■	■
NW1.2 Provide Wetland & Surface Water Buffers	■		■			■	■	■	■	■	■	■	■	■		■			■								■			■	■	■	■	■
NW1.3 Preserve Prime Farmland																				■										■	■	■	■	■
NW1.4 Preserve Undeveloped Land																																	
NW2.1 Reclaim Brownfields					■					■																					■			
NW2.2 Manage Stormwater		■	■			■	■		■	■	■	■	■	■					■								■	■					
NW2.3 Reduce Pesticide & Fertilizer Impacts				■	■	■		■	■									■															
NW2.4 Protect Surface & Groundwater Quality								■	■																		■						
NW3.1 Enhance Functional Habitats																														■	■	■	■	■
NW3.2 Enhance Wetland and Surface Water Functions	■								■	■	■	■							■								■	■					
NW3.3 Maintain Floodplain Functions													■	■																			
NW3.4 Control Invasive Species																		■															
NW3.5 Protect Soil Health	■				■	■			■	■																							
CR1.1 Reduce Net Embodied Carbon	■																																
CR1.2 Reduce Greenhouse Gas Emissions	■																																
CR1.3 Reduce Air Pollutant Emissions				■																													
CR2.1 Avoid Unsuitable Development						■	■																										
CR2.2 Assess Climate Change Vulnerability		■									■	■	■	■	■												■						
CR2.3 Evaluate Risk and Resilience			■										■	■	■																		

An overall observation is that Envision in its Natural World category refers explicitly to ecosystem services and ecosystem functions. According to the introduction of Natural World category, 'The natural systems around us perform critical functions called ecosystem services that provide us with clean air, clean water, healthy food, and hazard mitigation. The way a project is located within these systems and the new elements they may introduce to a system can create unwanted impacts on these ecosystem services. This section addresses how to understand and minimize negative impacts while considering ways in which the infrastructure can interact with natural systems in a synergistic, positive way."

In credits 'NW3.1 Enhance Functional Habitats' (for terrestrial habitats) and 'NW3.2 Enhance Wetland and Surface Water functions' (for aquatic habitats) the levels of achievements are structured upon the number of ecosystem functions that a project enhances. In the case of credit NW3.2 these functions are defined as hydrologic connection, water quality, aquatic/ riparian habitat and sediment transport/ sedimentation, while in the case of credit NW3.1 it is enhancement that is being defined as in quantity, quality and connectivity.

PART 5: SYNTHESIS OF FINDINGS AND INITIAL RECOMMENDATIONS

1. ENVISION PRIORITY CREDITS FOR ASSESSING BIODIVERSITY-RELATED PERFORMANCE

During the review of Envision against the high-priority criteria for biodiversity performance the following list of credits emerged as credits that address multiple criteria simultaneously. As expected the full set of Natural category credits are included in this list.

Table 42: Priority Envision credits for assessing biodiversity-related performance

CATEGORY	SUBCATEGORY		CREDITS (ENVISION VERSION 3)
NATURAL WORLD	Siting	1	NW1.1 Preserve Sites of High Ecological Value
		2	NW1.2 Provide Wetland & Surface Water Buffers
		3	NW1.3 Preserve Prime Farmland
		4	NW1.4 Preserve Undeveloped Land
	Conservation	5	NW2.1 Reclaim Brownfields
		6	NW2.2 Manage Stormwater
		7	NW2.3 Reduce Pesticide & Fertilizer Impacts
		8	NW2.4 Protect Surface & Groundwater Quality
	Ecology	9	NW3.1 Enhance Functional Habitats
		10	NW3.2 Enhance Wetland and Surface Water Functions
		11	NW3.3 Maintain Floodplain Functions
		12	NW3.4 Control Invasive Species
		13	NW3.5 Protect Soil Health
RESOURCE ALLOCATION	materials	14	RA1.5 Balance Earthwork on site
CLIMATE & RESILIENCE	emissions	15	CR1.3 Reduce Air Pollutant Emissions

A question that is raised is whether the identified biodiversity-related credits are prioritized in the Envision assessment as reflected in their scoring.

Table 43: Identified priority Envision credits sorted based on their score (from highest to lowest)

PRIORITY ENVISION CREDITS	Position based on sorting of scores	SCORE PER LEVEL OF ACHIEVEMENT				
		Improved	Enhanced	Superior	Conserving	Restorative
NW2.2 Manage Stormwater	7	2	4	9	17	**24**
NW2.1 Reclaim Brownfields	8	11	13	16	19	**22**
NW1.1 Preserve Sites of High Ecological Value	10	2	6	12	16	**22**
NW1.4 Preserve Undeveloped Land	15	3	8	12	18	20
NW3.2 Enhance Wetland & Surface Water Functions	16	3	7	12	18	20
NW1.2 Provide Wetland & Surface Water Buffers	18	2	5	10	16	20
NW2.4 Protect Surface and Groundwater Quality	19	2	5	9	14	20

NW3.1 Enhance Functional Habitats	26	2	5	9	15	18
CR1.3 Reduce Air Pollutant Emissions	27	2	4	9	14	18
NW1.3 Preserve Prime Farmland	36		2	8	12	16
NW3.3 Maintain Floodplain Functions	43	1	3	7	11	14
NW2.3 Reduce Pesticide & Fertilizer Impacts	52	1	2	5	9	12
NW3.4 Control Invasive Species	53	1	2	6	9	12
RA1.5 Balance Earthwork On Site	56	2	4	6	8	
NW3.5 Protect Soil Health	58		3	4	6	8

Preservation of critical ecosystems as a top priority for both climate change and biodiversity is reflected in the high score of relevant to 'preservation' credits:

- NW1.1 Preserve Sites of High Ecological Value
- NW1.4 Preserve Undeveloped Land
- NW1.2 Provide Wetland & Surface Water Buffers
- NW2.4 Protect Surface and Groundwater Quality
- NW1.3 Preserve Prime Farmland

Restoration and enhancement of ecosystems, next priority for integrated action is also reflected in the score of relevant credits:

- NW2.1 Reclaim Brownfields
- NW3.2 Enhance Wetland & Surface Water Functions
- NW3.1 Enhance Functional Habitats

The four credits with the lowest score represent credits with a supporting, yet necessary role in restoration and enhancement as well as in preservation of ecosystems. For example, in the case of credit NW3.5 Protect Soil Health, "disturbed soils (e.g. compacted) cannot hold water, nutrients, **or carbon** as well as natural, undisturbed soils. Disturbed soil is less capable of absorbing floodwaters or sustaining vegetation."[231]

2. IDENTIFIED GAPS AND RECOMMENDATIONS

The Envision review against the identified high priority criteria for biodiversity performance has shown a high alignment especially in higher levels of achievement. Some potential overall recommendations for consideration, in response to identified gaps, are:

- More consistent use of the terms 'no net loss' and 'net biodiversity gain' as they represent current global targets for biodiversity.
- Incorporate carbon sequestration potential and carbon storage capacity into the definition of high ecological value to reflect preservation and restoration of carbon rich ecosystems as a top priority from a joint climate-biodiversity perspective.
- Ecosystem services could be more explicitly referred to in credits to highlight the credit's potential for biodiversity action and integrated climate-biodiversity action.

[231] Envision Manual, Version 3

PART 6: USE OF CASE STUDIES

1. METHODOLOGY FOR THE SELECTION AND USE OF CASE STUDIES

A series of Envision verified projects have been selected and studied using a methodology built upon key research outcomes to apply and test them in specific projects. Case studies allow an understanding of context and location-specific parameters and enable a more detailed level of analysis. Projects provide examples of the risks and opportunities that will allow more detailed analysis and insights, such as:

- Understanding the risks & opportunities per type of project. There is a wide range of potential actions involving different processes, and it is hard to account for and capture the various risks. Impacts of climate change and climate action on biodiversity are presented through specific examples in the IPBES-IPCC report. The use of case studies allows for a more detailed analysis of climate-related risks and opportunities
- Understanding trade-offs of actions for climate change mitigation and adverse/unintended impacts on biodiversity.
- Linking the key criteria for climate action (the outcome of the 2020-21 research on climate change) and the key criteria for integrated climate-biodiversity action (the expected outcome of the ongoing 2021-22 research) for different types of infrastructure projects and identifying the relevant criteria per project type, which may not be 100% relevant to NbS projects.

1.1. Selection of Projects

The selection of projects for analysis aims to identify representative projects for integrated climate change and biodiversity action across different infrastructure sectors. We identified projects relevant to climate action in the 2020-21 research on climate change. We continue with the climate change – biodiversity nexus complementing the analysis of climate action with biodiversity-related action.

The methodology for selecting projects consists of:

- Use the 112 projects that have been Envision verified as of December 2021 in ISI's Database (https://sustainableinfrastructure.org/project-awards/) to identify representative projects with certified overall sustainable performance. The advantage of using the ISI project database is that the Envision rated projects have been presented/documented in a standardized way using Envision credit coversheets, allowing for comparisons in terms of actions per credit, quality or completeness of documentation per credit, identifying trends on what makes a high-performance project or what are the barriers that the project teams meet in pursuing higher levels of performance.
- Include both Envision V2 and V3 rated projects.
- The short-listing of projects is based on the following criteria:
  - Envision award level: platinum and gold award projects are selected to ensure high performance. The analysis of high-performance projects through the Envision assessment process provides insight into a trend in what constitutes a high-performance project.

- Infrastructure type: different infrastructure project types allow understanding of risks and opportunities per type of project. A wide range of potential project actions involve different processes, and it is difficult to account for and capture the different risks.
- Score: apart from the overall score that determines the Envision award, the focus is given to the scores in the RA and CR as more related to climate change performance and in the LD Category that reflects long-term planning and goal setting for climate action. Additionally, the score in the NW category is taken into consideration for integrated climate-biodiversity performance.

Currently, we have access to this information for 24 out of the 112 projects in the list of awarded projects:

Applying the above criteria to the initial list of 112 Envision awarded projects:

Table 44: No. of shortlisted projects with award level= platinum or gold per infrastructure type

	Award level		**Infrastructure type/ Sector**					
	Platinum	gold	energy	transportation	water	waste	Land/environment	Food
No. of projects	39	21	12	21	19	1	6	1
			A total of 60 projects across six different sectors achieved platinum or gold award					

For the shortlisted 60 projects, scores per category are available for 26 projects, as shown in the table below:

Table 45: Available scores per Envision category for platinum and gold awarded projects

PROJECT		SECTOR	YEAR	AWARD LEVEL	SCORE (%)				
					QL	LD	RA	NW	CR
1	William Jack Hernandez Sport Fish Hatchery, Anchorage, AK	Land/Environment	2013	**Gold**	50%	64%	32%	57%	18%
2	Snow Creek Stream Environment Zone Restoration Project, Placer County, CA	Land/Environment	2013	**Platinum**	77%	48%	34%	92%	45%
3	South Los Angeles Wetland Park, Los Angeles, CA	Water	2014	**Platinum**	57%	56%	43%	92%	21%
4	Sun Valley Watershed Multi-Benefit Project, Los Angeles, CA	Water	2014	**Platinum**	75%	85%	39%	86%	55%
5	Low-Level Road, North Vancouver, BC	Transportation	2015	**Platinum**	78%	61%	21%	54%	66%
6	Ridgewood View Reservoir and Pump Station, Portland, OR	Water	2016	**Gold**	58%	70%	36%	40%	57%

7	Kansas City Streetcar, Kansas City, MO	Transportation	2016	**Platinum**	91%	62%	27%	25%	43%
8	Ohio River Bridges - East End Crossing, Jeffersonville, IN	Transportation	2016	**Platinum**	92%	79%	13%	46%	57%
9	Nutrient Management Facility, Alexandria, VA	Wastewater	2016	**Platinum**	53%	59%	49%	75%	40%
10	Highway (I-4 Ultimate), Orlando, FL	Transportation	2017	**Platinum**	81%	79%	26%	44%	23%
11	CIP 2406 - Digester Gas Utilization Project, Los Angeles, CA	Energy	2018	**Platinum**	47%	56%	55%	85%	48%
12	TIWRP - Advanced Water Purification Facility, Los Angeles, CA	Wastewater	2018	**Platinum**	52%	56%	48%	62%	61%
13	Santa Monica Clean Beaches Project, Santa Monica, CA	Water	2019	**Gold**	35%	47%	51%	55%	43%
14	Itinerario ferroviario Napoli-Bari. Tratta Apice – Orsara, 1° Lotto Funzionale Apice – Hirpinia, Napoli, Italy	Transportation	2020	**Platinum**	97%	64%	18%	41%	65%
15	California High-Speed Rail Program (Phase I), Sacramento, CA	Transportation	2020	**Platinum**	80%	75%	61%	25%	93%
16	Starlight Park - Phase II, Bronx, NY	Land/Environment	2021	**Gold**	87%	48%	22%	61%	5%
17	Dubuque Solar project, Dubuque, IA	Energy	2018	**Platinum**	52%	46 %	46%	46%	79%
18	English Farms Wind Farm, Montezuma, IA	Energy	2019	**Platinum**	36%	59%	46%	46%	80%
19	Upland Prairie Wind farm, Everly, IA	Energy	2019	**Platinum**	36%	59%	46%	46%	76%
20	Historic Fourth Ward Park, Atlanta, GA	Land/Environment	2016	**Gold**	71%	56%	21%	56%	13%
21	Berryessa Transit Center, San Jose, CA	Transportation	2021	**Platinum**	69%	60%	24%	74%	24%
22	Garage souterrain Côte-Vertu, Montréal, QC, Canada	Transportation	2021	**Platinum**	45%	81%	58%	57%	58%

23	Gordie Howe International Bridge, Detroit, MI	Transportation	2021	**Platinum**	90%	81%	37%	59%	62%
24	Georgetown Wet Weather Treatment station project, Seattle, WA	Water	2018	**Platinum**	-	-	53%	65%	59%
25	City of Los Angeles' Middle Blue River basin project, Kansas City, MO	Water/ Landscape	2016	**Platinum**	81%	76%	24%	65%	30%
26	Oxford Retention Basin Multi-use project, Los Angeles, CA	Water/ Landscape	2021	**Platinum**	86%	**54%**	18%	**83%**	**34%**
				overall average score	**68%**	**63%**	**36%**	**59%**	**49%**
				overall max. score	**97%**	**85%**	**61%**	**92%**	**93%**

While the process of completing the information on the scores for the rest of the projects is still ongoing, an initial analysis focuses on average and maximum values per Envision category to enable an initial further short-listing using the score in RA, CR, and LD as a selection criterion for identifying projects with higher-than-average climate change-related performance.

		LD	**RA**	**NW**	**CR**
William Jack Hernandez Sport Fish Hatchery, Anchorage, AK	**Gold**	64%	32%	57%	18%
Snow Creek Stream Environment Zone Restoration Project, Placer County, CA	**Platinum**	48%	34%	**92%**	45%
South Los Angeles Wetland Park, Los Angeles, CA	**Platinum**	56%	43%	**92%**	21%
Sun Valley Watershed Multi-Benefit Project, Los Angeles, CA	**Platinum**	85%	39%	86%	55%
Low-Level Road, North Vancouver, BC	**Platinum**	61%	21%	54%	66%
Ridgewood View Reservoir and Pump Station, Portland, OR	**Gold**	70%	36%	40%	57%
Kansas City Streetcar, Kansas City, MO	**Platinum**	62%	27%	25%	43%
Ohio River Bridges - East End Crossing, Jeffersonville, IN	**Platinum**	79%	13%	46%	57%
Nutrient Management Facility, Alexandria, VA	**Platinum**	59%	49%	75%	40%
Highway (I-4 Ultimate), Orlando, FL	**Platinum**	79%	26%	44%	23%
CIP 2406 - Digester Gas Utilization Project, Los Angeles, CA	**Platinum**	56%	55%	85%	48%
TIWRP - Advanced Water Purification Facility, Los Angeles, CA	**Platinum**	56%	48%	62%	61%
Santa Monica Clean Beaches Project, Santa Monica, CA	**Gold**	47%	51%	55%	43%

Itinerario ferroviario Napoli-Bari, Napoli, Italy	**Platinum**	64%	18%	41%	65%
California High-Speed Rail Program (Phase I), Sacramento, CA	**Platinum**	75%	**61%**	25%	**93%**
Starlight Park - Phase II, Bronx, NY	**Gold**	48%	22%	61%	5%
Dubuque Solar project, Dubuque, IA	**Platinum**	46 %	46%	46%	79%
English Farms Wind Farm, Montezuma, IA	**Platinum**	59%	46%	46%	80%
Upland Prairie Wind farm, Everly, IA	**Platinum**	59%	46%	46%	76%
Historic Fourth Ward Park, Atlanta, GA	**Gold**	56%	21%	56%	13%
Itinerario ferroviario Napoli-Bari, tratta Frasso Telesino-S. Lorenzo, Napoli, Italy	**Platinum**	55%	16%	41%	65%
Berryessa Transit Center, San Jose, CA	**Platinum**	64%	24%	74%	24%
Garage souterrain Côte-Vertu, Montreal, QC, Canada	**Platinum**	81%	58%	57%	58%
Gordie Howe International Bridge, Detriot, MI	**Platinum**	81%	37%	59%	62%
Georgetown Wet Weather Treatment station, Seattle, WA	**Platinum**		53%	65%	59%
Middle Blue River basin project, Kansas City, MO	**Platinum**	76%	24%	65%	30%
Oxford Retention Basin Multi-use project, Los Angeles, CA	**Platinum**	54%	18%	83%	34%

Then, the score in the NW category is also added as a criterion to identify projects with integrated climate-biodiversity high-performance. Below-average performance in one of the ENV categories is not automatically excluding a project from being used as a case study. Instead, it provides the potential of understanding the barriers that the project teams met in achieving higher levels of achievement in those categories.

Finally, it is also worth highlighting that obtaining the scores per category for as many Envision awarded projects as possible (silver and verified projects included) provides the additional potential for more informed insights on the Envision assessment process itself, apart from providing a more representative overall average and maximum values for the proposed analysis. For example:

- if there are trends on what makes a high-performance project,
- what are the barriers that project teams meet in achieving higher levels of achievement?

The second step of short-listing projects is based on an overview of Envision verified projects and the summaries available on the ISI site and other publicly available information by the project teams as preparatory work for identifying potential case study projects and narrowing the list of projects for which to request material. This initial information review can potentially enable distinguishing projects into:

(a) Projects that respond to climate action urgency: projects where climate change mitigation or adaptation are the principal services of the project.
(b) Projects in which climate change mitigation or adaptation is not the principal service of the project but have the potential to contribute to climate change mitigation and adaptation

The climate action potential must be highlighted as a quality that strengthens their business case. It is particularly relevant in the case of a future generalized trend that all projects must prove a positive climate action. The range across different types of climate action can be distinguished in:

- technical/ technological solutions,
- Nature-based Solutions (NbS),[232] and
- combined technical/ technological- Nature-Based Solutions.

The above classification of projects determines from the outset if biodiversity is part of a project's climate action strategy. Technical & technological solutions and combined solutions enable a review of the **impact** of climate actions on biodiversity and the relation between such impact and the type of a project. In contrast, NbS and combined solutions allow for studying (a) biodiversity opportunities for climate action and (b) the trade-offs on the provision of other ecosystem services, other than carbon sequestration or flood protection, etc. It will show if the multi-benefit potential of NbS is accounted for in such solutions. Thus, opportunities will be studied in the case of combined solutions & NbS, as the previous research covers the technical solutions.

1.2. Request for Information

For new projects

A generic request for material has been developed for information on climate change-related performance. This request is based on the selected list of credits identified as 'high-priority' credits for assessing climate action, the 2020-21 research outcome.

Table 46: Priority Envision credits for Assessment of climate change-related performance (V3)

Category	Subcategory	Credit
CLIMATE & RESILIENCE	Emissions	CR1.1 Reduce Net Embodied Carbon
		CR1.2 Reduce Greenhouse Gas Emissions
	Resilience	CR2.1 Avoid Unsuitable Development
		CR2.2 Assess Climate Change Vulnerability
		CR2.3 Evaluate Risk and Resilience
		CR2.4 Establish Resilience Goals and Strategies
		CR2.5 Maximize Resilience
		CR2.6 Improve Infrastructure Integration
RESOURCE ALLOCATION	Materials	RA1.1 Support Sustainable Procurement Practices
		RA1.2 Use Recycled Materials
		RA1.3 Reduce Operational Waste
		RA1.4 Reduce Construction Waste

[232] It is worth mentioning that the on-going literature review will provide input on what NbS encompass.

	Energy	RA2.1 Reduce Operational Energy Consumption
		RA2.2 Reduce Construction Energy Consumption
		RA2.3 Use Renewable Energy
		RA2.4 Commission & Monitor Energy Systems
	Water	RA3.1 Preserve Water Resources
		RA3.2 Reduce Operational Water Consumption
		RA3.3 Reduce Construction Water Consumption
		RA3.4 Monitor Water Systems
	Innovation	RA0.0 Innovate or Exceed Credit Requirements
LEADERSHIP	Collaboration	LD1.4 Pursue Byproduct Synergies
	Planning	LD2.3 Plan for Long-Term Monitoring and Maintenance
		LD2.4 Plan for end-of-life
	Economy	LD3.3 Conduct a Life-Cycle Economic Evaluation
NATURAL WORLD	Conservation	NW2.2 Manage Stormwater
	Ecology	NW3.3 Maintain Floodplain Functions
QUALITY OF LIFE	Purpose	QL1.6 Minimize Construction Impacts
	Well-being	QL2.1 Improve Community Mobility
		QL2.2 Encourage Sustainable Transportation
		QL 2.3 Improve Access & Wayfinding

Envision V3 is the basis of the research. The V2 list of priority credits has also been developed to request material for projects reviewed in V2.

Table 47: Priority Credits for Envision Version 3 linked to their equivalent in Envision Version 2

Priority Credit (V3)	Priority Credit (V2)
CR1.1 Reduce Net Embodied Carbon	RA1.1 Reduce Net Embodied Energy
	RA1.4 Use Regional Materials
CR1.2 Reduce Greenhouse Gas Emissions	CR1.1 Reduce Greenhouse Gas Emissions
CR2.1 Avoid Unsuitable Development	NW1.4 Avoid Adverse Geology
	NW1.6 Avoid unsuitable Development on Steep Slopes
CR2.2 Assess Climate Change Vulnerability	CR2.1 Assess Climate Threat
CR2.3 Evaluate Risk and Resilience	
CR2.4 Establish Resilience Goals and Strategies	
CR2.5 Maximize Resilience	CR2.2 Avoid traps and Vulnerabilities
	CR2.3 Prepare for Long-Term Adaptability
	CR2.4 Prepare for Short-Term Hazards
	CR2.5 Manage Heat Islands Effects
CR2.6 Improve Infrastructure Integration	LD2.2 Improve Infrastructure Integration
RA1.1 Support Sustainable Procurement Practices	RA1.2 Support Sustainable Procurement Practices
RA1.2 Use Recycled Materials	RA1.3 Use Recycled Materials
RA1.3 Reduce Operational Waste	RA1.5 Divert Waste From landfills
RA1.4 Reduce Construction Waste	
RA2.1 Reduce Operational Energy Consumption	RA2.1 Reduce Energy Consumption
RA2.2 Reduce Construction Energy Consumption	
RA2.3 Use Renewable Energy	RA2.2 Use Renewable Energy
RA2.4 Commission & Monitor Energy Systems	RA2.3 Commission & Monitor Energy Systems
RA3.1 Preserve Water Resources	RA3.1 Protect Fresh Water Availability

RA3.2 Reduce Operational Water Consumption	RA3.2 Reduce Potable Water Consumption
RA3.3 Reduce Construction Water Consumption	
RA3.4 Monitor Water Systems	RA3.3 Monitor Water Systems
LD1.4 Pursue Byproduct Synergies	LD2.1 Pursue By-Product Synergy Opportunities
LD2.3 Plan for Long-Term Monitoring and Maintenance	LD3.1 Plan for Long-Term Monitoring and Maintenance
LD2.4 Plan for end-of-life	LD3.3 Extend Useful Life
	RA1.7 Provide for Deconstruction and Recycling
LD3.3 Conduct a Life-Cycle Economic Evaluation	
NW2.2 Manage Stormwater	NW2.1 Manage Stormwater
NW3.3 Maintain Floodplain Functions	NW1.5 Preserve Floodplain Functions

Given that Envision V3 introduced some new requirements, for example, in the case of the construction phase of a project, it is expected that V2-rated projects are lacking this type of documentation.

Table 48: Priority Envision credits for Assessment of climate change-related performance (V2)

Category	Subcategory	Credit
CLIMATE & RISK	Emissions	CR1.1 Reduce Greenhouse Gas Emissions
	Resilience	CR2.1 Assess Climate Threat
		CR2.2 Avoid traps and Vulnerabilities
		CR2.3 Prepare for Long-Term Adaptability
		CR2.4 Prepare for Short-Term Hazards
		CR2.5 Manage Heat Islands Effects
RESOURCE ALLOCATION	Materials	RA1.1 Reduce Net Embodied Energy
		RA1.2 Support Sustainable Procurement Practices
		RA1.3 Use Recycled Materials
		RA1.4 Use Regional Materials
		RA1.5 Divert Waste From landfills
		RA1.7 Provide for Deconstruction and Recycling
	Energy	RA2.1 Reduce Energy Consumption
		RA2.2 Use Renewable Energy
		RA2.3 Commission & Monitor Energy Systems
	Water	RA3.1 Protect Fresh Water Availability
		RA3.2 Reduce Potable Water Consumption
		RA3.3 Monitor Water Systems
LEADERSHIP	Management	LD2.1 Pursue By-Product Synergy Opportunities
		LD2.2 Improve Infrastructure Integration
	Planning	LD3.1 Plan for Long-Term Monitoring and Maintenance
		LD3.3 Extend Useful Life
NATURAL WORLD	Siting	NW1.4 Avoid Adverse Geology
		NW1.5 Preserve Floodplain Functions
		NW1.6 Avoid Unsuitable Development on Steep Slopes
	Land & Water	NW2.1 Manage Stormwater
QUALITY OF LIFE	Well-being	QL2.4 Improve Community Mobility and Access
		QL2.5 Encourage Alternative Modes of Transportation

		QL2.6 Improve Site Accessibility, Safety, and Wayfinding

The QL credits are requested only for transportation projects.

The above tables focus on assessing climate change mitigation and adaptation performance. The NW category credits provide an assessment of integrated climate-biodiversity performance. The entire list of Envision's NW credits is requested since we have not yet prioritized the biodiversity-related credits.

The request is supplemented with the Innovation credits for the RA, CR, and NW categories. These credits capture additional strategies that exceed the Envision performance requirements and can potentially be relevant to climate change action.

Appendix D shows the request for generic documents for both V2 and V3.

Material has been received for the following projects:

Transportation projects

California High-speed Rail Authority's CHSR program (Platinum, 2020)
Windsor Detroit Bridge Authority's Gordie Howe International Bridge, Ontario CAN & Michigan USA. (Platinum, 2021)
STM's Côte-Vertu underground garage - 3 buildings & 1 rail track, Montreal, Canada (Platinum, 2021)
Santa Clara Valley Transportation Authority (VTA's) Berryessa Transit Center, San Jose, CA. (Platinum, 2021)

Energy infrastructure projects

Alliant Energy's English Farms and Upland Prairie Wind projects (Platinum, 2019)
Alliant Energy's Dubuque Solar Project (Platinum, 2018)
City of Los Angeles Bureau of Engineering's Hyperion Water Reclamation Plant Digester Gas Utilization Project (Platinum, 2018)
Alliant Energy's Dubuque Solar farm project (Platinum, 2018)

Water projects

City of Santa Monica's Clean Beaches project (Gold, 2019)
LA City BOE's TIWRP- Advanced Water Purification Facility (Platinum, 2018)
King County Wastewater Treatment Division's Georgetown Wet Weather Treatment Station (WWTS) (Platinum, 2018)

Landscape projects

City of Atlanta Department of Watershed Management's Historic Fourth Ward Park, Atlanta, GA (Gold, 2016)
City of Los Angeles' Middle Blue River Basin, Kansas City, MO (stormwater control project) (Platinum, 2016)
County of Los Angeles Department of Public Works' Oxford Retention Basin Multi-use project, Los Angeles, CA (flood control project) (Platinum, 2021)

2. METHODOLOGY FOR THE ANALYSIS OF PROJECTS

The analysis of selected projects for integrated climate-biodiversity performance was performed in two main parts:

- Part 1: Climate change mitigation & adaptation performance
- Part 2: Biodiversity-related performance

For both parts of analysis a four-step methodology was used:

Step 1: Review coversheets of the priority Envision credits for climate change and biodiversity.
The projects used as case studies are infrastructure projects that have been assessed and verified through the Envision verification process. As part of this process, the project teams complete online coversheets for each Envision credit and document supported by project documentation to demonstrate their performance per credit. For a more targeted analysis of projects, the review of project material focuses on the priority Envision credits for assessing climate change and biodiversity action.
Step 2: Create a list of the project strategies that are presented in the priority credits coversheets
These strategies are directly or indirectly related to climate change mitigation and adaptation and biodiversity risk management.
Step 3: Link the list of the project's strategies with the high-priority criteria to show the criteria addressed per project strategy.
Step 4: Synthesis of findings and initial conclusions over the relevance of the criteria per infrastructure project type (transportation, energy, water, and landscape infrastructure)

Table 49: Key criteria for assessment of climate change-related performance

Assessment of transition risks (mitigation):	Assessment of physical risks (adaptation):	Climate physical opportunities:
A. GHG emissions reduction targets & progress against targets (GHG accounting): • GHG Scope 1 emissions • GHG Scope 2 emissions • GHG Scope 3 emissions • GHG Scope 3 emissions (user) **B. GHG emissions reduction strategies:** 1. Energy efficiency 2. Electricity decarbonization using renewable energy sources 3. Electrification	**C. Inclusion of TCFD recommended disclosures for:** 1. Risk evaluation process 2. Risk management process **D. Exposure to climate-related risks:** 1. service continuity risk 2. physical asset risk 3. resource availability risk • water • materials • land • workforce 4. supply chain continuity risk	**E. Core principles of resilient systems:** a. Resource efficiency b. Durability c. Adaptability d. Redundancy e. Integration f. Reflective capacity g. Inclusivity

(replacement of the use of fossil fuels with electricity) 4. Carbon capture and sequestration for the hard-to-electrify portions of systems		

The priority Envision credits have a supporting role in the above analysis. They assist in the process of finding the relevant to priority criteria information within the Envision credit cover sheets' documentation. Thus, the project strategies that address the priority criteria are identified.

PART 7: CONCLUSIONS AND OVERALL RECOMMENDATIONS

1. INTEGRATED CLIMATE-BIODIVERSITY PERFORMANCE

The 2020-21 Research on climate action highlighted a set of criteria for assessing a project's performance in managing climate change-related risks. Moreover, the research highlighted a subset of the criteria, the 'core principles of resilient systems' as climate opportunities because of their joint benefit for both climate change mitigation and adaptation risk management:

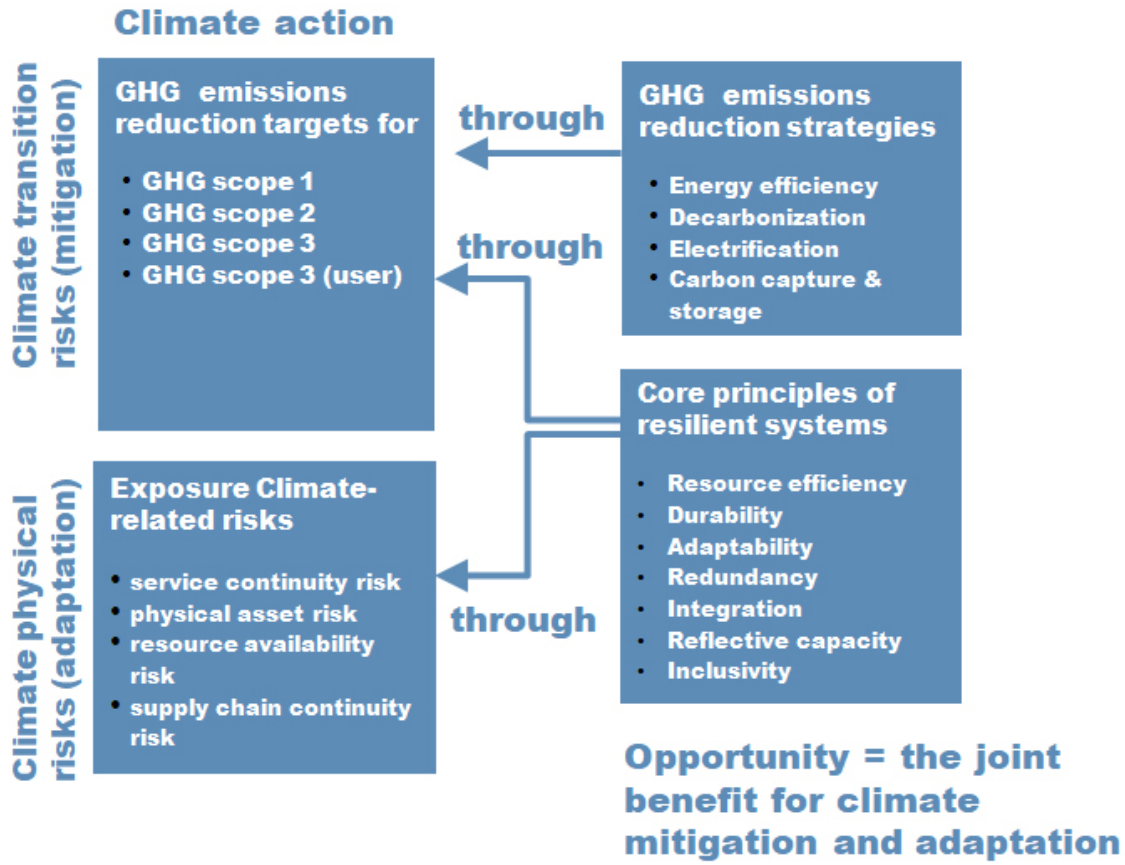


Fig. 31: Management of climate change-related risks (graph by author)
The Core principles of resilient systems are recognized as climate-related opportunities due to their joint benefit for both climate mitigation and adaptation

In a similar manner the 2021-22 Research on integrated climate- biodiversity action highlighted a set of criteria necessary for managing biodiversity-related risks. The four subsets of biodiversity criteria are interlinked.

This section aims to highlight the linkages of the biodiversity criteria with the climate change criteria. To do so instead of referring to infrastructure projects in general we refer specifically to climate action

projects, examples of which were studied as part of the case studies. The integrated climate-biodiversity performance of projects has been defined based on inclusion of project strategies that:

1. Contribute to both climate change mitigation and/or adaptation and biodiversity (in other words address both climate change and biodiversity high-priority criteria)
2. Contribute to climate change action without adverse impact on biodiversity (address the 'pressures on biodiversity' criterion)

The first category of strategies applies to Nature-based solutions and highlights their potential as opportunities, to manage both biodiversity-related and climate change-related risks.

The second category represents the minimum criteria that climate action projects should address and includes climate change-related strategies related to:

- Project useful life extension
- Material sourcing from suppliers with sustainable practices
- Reduction of material input
- End-of-Life repurposing
- Solid waste diversion
- Reduction of potable water use
- Purchase of carbon offsets
- Stormwater and flood control (through technical/ technological solutions)

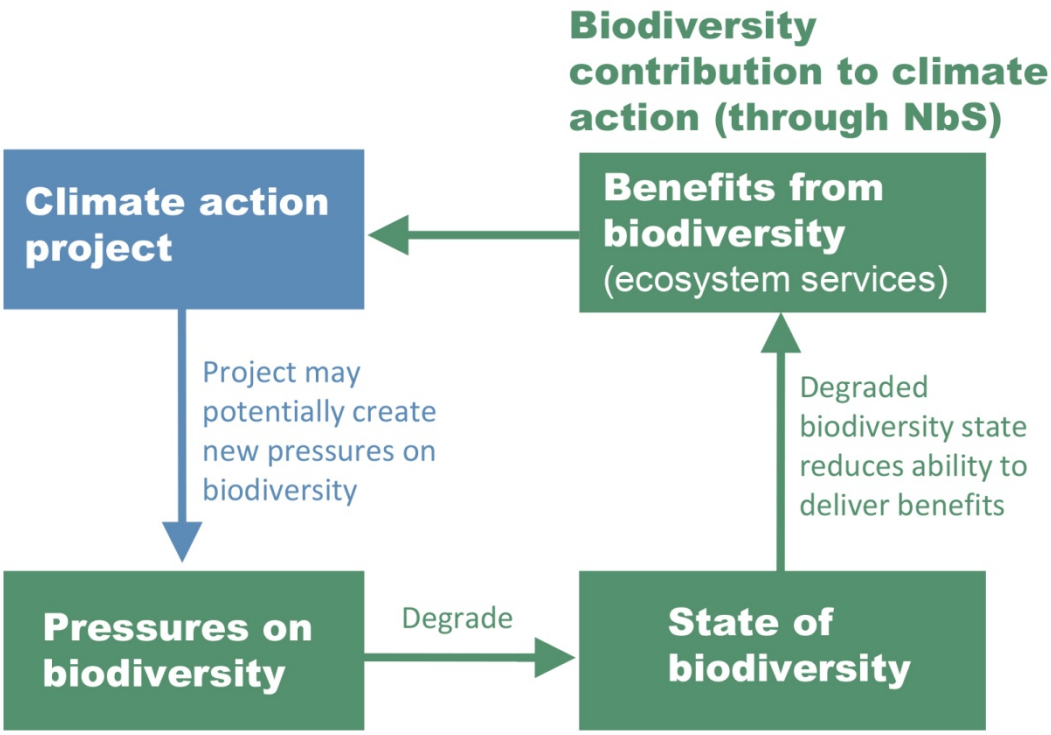


Fig. 32: Defining integrated climate-biodiversity project performance (graph by author)
Reduced ability to deliver biodiversity benefits undermines biodiversity's potential contribution to climate action
This risk is managed through the biodiversity management responses: avoidance, minimization, restoration, offset, renew.
Therefore, for demonstrating integrated climate-biodiversity action, a climate action project should incorporate NbS and at the same time, or as a minimum manage all potential project-driven pressures (e.g. during construction, project process specific pressures during operation, during maintenance and end-of-life) to ensure the long-term resilience of delivery of ecosystem services.

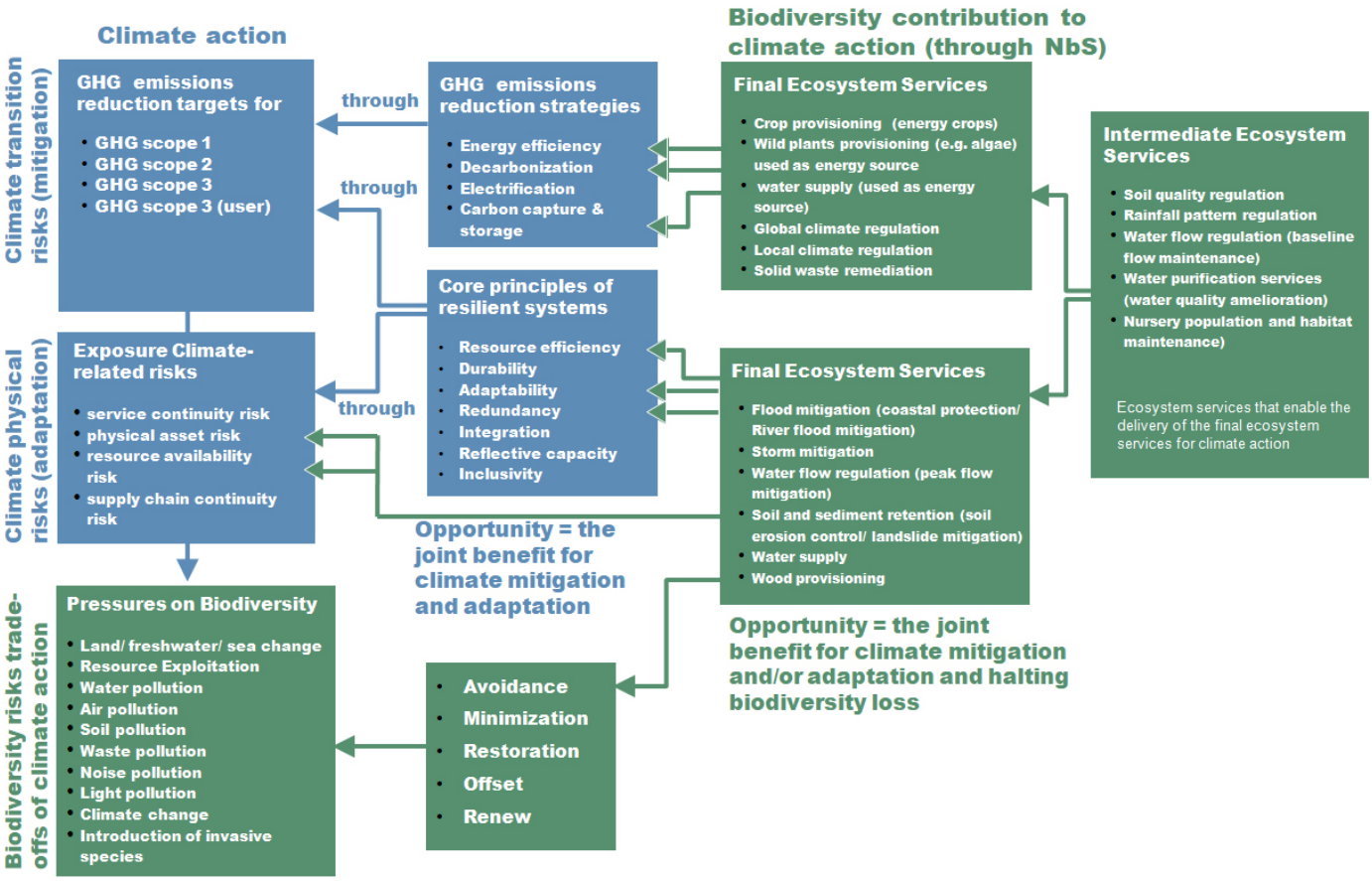


Fig. 33: Integrated climate-biodiversity action – which climate change-related criteria can be addressed by biodiversity (graph by author)

Two types of opportunities emerge:

- The core principles of resilient systems (or climate physical opportunities)
- the Nature-based solutions (NbS)

These are opportunities because, the former has a joint benefit for both climate change mitigation and adaptation and the latter because of its joint benefit for climate mitigation and /or adaptation and halting biodiversity loss.

1.1. Nature-based Solutions to Climate Action and Biodiversity Action

In Table 50 the high-priority criteria for climate change and biodiversity are presented in a way that takes into consideration the overlaps between the two sets of criteria (also see Appendix F) and map the areas of potential contribution by NbS to both climate change criteria and pressures on biodiversity.

Table 50: Detailed contribution of biodiversity to climate change mitigation and climate change adaptation through Nature-based solutions

	GHG EMISSIONS REDUCTION TARGETS FOR:		GHG EMISSIONS REDUCTION STRATEGIES & CORE PRINCIPLES OF RESILIENT SYSTEMS	FINAL ECOSYSTEM SERVICES (FES)	INTERMEDIATE ECOSYSTEM SERVICES (that support the delivery of final ES)	
CLIMATE TRANSITION RISKS (MITIGATION)	GHG scope 1 emissions		De-carbonization	Crop provisioning (energy crops)	Soil quality regulation	
				Wild plants provisioning(terrestrial, aquatic e.g.algae) used as energy source		
				Water supply (used as energy source)	Rainfall pattern regulation services (at sub-continental scale)	
					Water flow regulation (Baseline flow maintenance)	
			Electrification			
			Carbon capture & storage	Global climate regulation (including carbon sequestration and storage)	Nursery population and habitat maintenance	carbon sink: vegetation
					Water purification services (water quality amelioration)	carbon sink: water
					Soil quality regulation	carbon sink: soil
	GHG scope 2 emissions		Energy efficiency	Local (micro and meso) climate regulation		
	GHG scope 3 emissions		Resource efficiency (materials) (reuse/ downsizing)			
				Solid waste remediation		
			Durability			
				Local (micro and meso) climate regulation		
			Integration			
			Inclusivity			
	GHG scope 3 emissions (user)		De-carbonization			
			Energy efficiency	Local (micro and meso) climate regulation		
	EXPOSURE TO CLIMATE-RELATED RISKS		**CORE PRINCIPLES OF RESILIENT SYSTEMS**	**FINAL ECOSYSTEM SERVICES (FES)**	**INTERMEDIATE ECOSYSTEM SERVICES**	
CLIMATE PHYSICAL RISKS (ADAPTATION)	Service continuity risk		Adaptability			
			Redundancy			
			Reflective capacity			
	Physical asset risk		Durability	Local (micro and meso) climate regulation		
				Storm mitigation (other than water-related events)		
			Adaptability			
			Redundancy			
				Flood mitigation (Coastal protection /River flood mitigation		
				Water flow regulation (Peak flow mitigation)		
				Soil and sediment retention (Soil erosion control/Landslide mitigation)		
	Resource availability risk (for future long-term needs)	water	Resource efficiency (water)	Water supply	Rainfall pattern regulation services (at sub-continental scale)	
					Water flow regulation (Baseline flow maintenance)	
		materials	Resource efficiency (materials) (reuse/ downsizing/alternative materials)	Wood provisioning		
				Sand, rock, gravel etc.		
			Integration			
		land	Integration			
		workforce				
	Supply chain continuity risk		Redundancy			
	&					
PRESSURES ON BIODIVERSITY	Land, freshwater, sea change					
	Pollution	Water		Water purification (retention and breakdown of nutrients/ other pollutants)	Soil quality regulation	
		Air		Air filtration	Nursery population and habitat maintenance	
		Soil		Soil quality regulation		
				Pest control		
		Waste		Solid waste remediation		
		Noise		Noise attenuation		
		light				
	Introduction of invasive species					

Table 51: Examples of Nature-based Solutions that contribute to climate change mitigation and adaptation

Type of NbS	Related Envision credit	Biodiversity-related performance criteria	Climate change performance criteria
Preservation / Restoration of terrestrial ecosystems	NW1.1 NW1.3 NW1.4 NW2.1	• Global climate regulation • Local climate regulation • Air filtration • Soil quality regulation • Soil and sediment retention • Solid waste remediation • Water purification • Water flow regulation • Flood mitigation • Noise attenuation • Pest control • Nursery population and habitat maintenance	• Carbon capture & storage • Physical asset risk • Energy efficiency • Adaptability • Redundancy
Preservation / restoration of aquatic ecosystems	NW1.2 NW2.4 NW3.3	• Global climate regulation • Local climate regulation • Air filtration • Soil and sediment retention • Retention and breakdown of nutrients/ other pollutants • Water flow regulation • Flood mitigation • Nursery population and habitat maintenance • Water supply	• Carbon capture & storage • Physical asset risk • Energy efficiency • Resource availability risk (water) • Resource efficiency (water) • Adaptability • Redundancy
Expansion/ Creation of new ecosystems (e.g. revegetation)	NW3.1	• Global climate regulation • Local climate regulation • Air filtration • Soil quality regulation • Soil and sediment retention • Solid waste remediation • Water purification • Water flow regulation • Flood mitigation • Noise attenuation • Pest control • Nursery population and habitat maintenance	• Carbon capture & storage • Physical asset risk • Energy efficiency • Adaptability • Redundancy
Creation of new ecosystems	NW3.2	• Local climate regulation • Soil and sediment retention • Retention and breakdown of	• Physical asset risk • Energy efficiency • Resource availability risk (water)

(e.g. bioretention basins)		nutrients/ other pollutants • Water flow regulation • Flood mitigation • Nursery population and habitat maintenance • Water supply (non-potable for use as material)	• Resource efficiency (water) • Adaptability • Redundancy

1.2. Climate action to Biodiversity Action

A climate action project if not incorporating NbS, should as a minimum manage through technical/ technological solutions all potential project-driven pressures (e.g. during construction, project process specific pressures during operation, during maintenance and end-of-life) to ensure the long-term resilience of delivery of existing ecosystem services.

Table 52: Examples of climate action project strategies that address as minimum project-driven pressures in biodiversity (based on the study of selected projects):

Type of strategies	Related priority credits	Climate change-related performance criteria	Biodiversity –related performance criteria (pressures on biodiversity)
Project Useful Life Extension	CR2.5 CR2.6 LD2.3 LD2.4	• Durability • Redundancy • Adaptability • Integration • Resource efficiency (materials) • Resource availability risk (materials) • GHG scope 3 emissions • GHG scope 1 & 2 emissions (from avoided future works)	(upstream pressures) • resource exploitation (materials) • land change (for extraction) (downstream pressures) • Waste pollution • land change (for landfilling) • water pollution (from landfilling)
Protection against extreme events	CR2.1 CR2.2 CR2.3 CR2.4	• Durability • Redundancy • Adaptability • GHG scope 3 emissions • Resource efficiency(materials) • Resource availability risk (materials) • GHG scope 1 & 2 emissions (from avoided future works)	(upstream) • Resource exploitation (materials) • Land change (for extraction) (downstream) • Waste pollution • Land change (for landfilling) • Water pollution (from landfilling)
Material sourcing from sustainable practice suppliers	RA1.1	• GHG scope 3 emissions And potentially: • Resource availability risk (materials, water, land)	These strategies reduce various upstream pressures on biodiversity depending on the supplier's type of activity, sustainability management system etc.
Reduction of material input	LD1.4 LD2.3 RA1.2 CR1.1	• GHG scope 3 emissions • Durability • Integration • Resource efficiency	(upstream pressures) • Resource exploitation (materials) • Land change for extraction (downstream pressures)

	CR2.5 CR2.6	• Resource availability risk (water, materials)	• Waste pollution
End-of-Life repurposing	LD2.4	• GHG scope 3 emissions • Resource availability risk (materials)	(downstream pressures): • waste pollution • land change for landfills, • potential water pollution from landfill (upstream pressures) • Resource exploitation (materials and water) for new material production for other projects
Solid waste diversion	RA1.3 RA1.4	• GHG scope 3 emissions • Resource availability risk (water, land)	(downstream pressures): • Waste pollution • Land change for landfills, • Potential water pollution from landfill
Reduction of potable water use	RA3.1 RA3.2 RA3.3 RA3.4	• Resource efficiency (water) • Resource availability (water)	these strategies reduce water resource exploitation during project operation
Stormwater and flood control	CR2.2 CR2.3 NW2.2 NW3.3	• Physical asset risk • Resource efficiency (water) • GHG scope 1, 2 & 3 emissions (from avoided future works)	• Water pollution
Purchase of carbon offsets	CR1.2	• Carbon capture and storage	• Land change

ABBREVIATIONS

CBD Convention for Biological Diversity
CDSB Climate Disclosure Standards Board
CICES European Environmental Agency's (EEA) Common International Classification of Ecosystem Services
COP Conference of the Parties
ES Ecosystem Services
EU European Union
FES Final Ecosystem Services
GHG Greenhouse Gas
GRESB Global Real Estate Sustainability Benchmark
GRI Global Reporting Initiative
IBC International Business Council
IPBES Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC Intergovernmental Panel on Climate Change
IUCN International Union for Conservation of Nature
LTS Long-Term Strategies
LULUCF Land use, land use change and forestry
MA Millennium Ecosystem Assessment
MAES EU's Mapping and Assessment of Ecosystems and their Services
NbS Nature-based Solutions
NBSAPs National Biodiversity Strategies and Action Plans
NCPs IPBES Nature's Contribution to People
NDCs Nationally Determined Contributions
NESCS US Environmental Protection Agency (USEPA) National Ecosystem Services Classification System
SASB Sustainability Accounting Standards Board
SBT Science-based Target
SBTN Science-based Targets Network
SEEA EA United Nations System of Environmental-Economic Accounting Ecosystem Accounting
STAR Species threat abatement and Recovery
TCFD Task Force on Climate-related Financial Disclosures
TNFD Task Force on Nature-related Financial Disclosures
TEEB UNEP's the Economics of Ecosystems and Biodiversity
UN United Nations
UNEP United Nations Environmental Programme
UNFCCC United Nations Framework Convention on Climate Change
WEF World Economic Forum

APPENDIX A

AICHI BIODIVERSITY TARGETS[233]

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

	**Target 1: Awareness of biodiversity increased** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
	**Target 2: Biodiversity values integrated** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
	**Target 3: Incentives reformed** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.
	**Target 4: Sustainable production and consumption** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

	**Target 5: Habitat loss halved or reduced** By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
	**Target 6: Sustainable management of aquatic living sources** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.
	**Target 7: Sustainable agriculture, aquaculture and forestry** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
	**Target 8: Pollution reduced** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
	**Target 9: Invasive alien species prevented and controlled** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
	**Target 10: Ecosystems vulnerable to climate change** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

[233] https://www.cbd.int/sp/targets/

	**Target 11: Protected Areas** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, **especially areas of particular importance for biodiversity and ecosystem services**, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
	**Target 12: Reducing risk of extinction** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.
	**Target 13: Safeguarding genetic diversity** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

	**Target 14: Ecosystem services** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.
	**Target 15: Ecosystem restoration and resilience** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.
	**Target 16: Access to and sharing benefits from genetic resources** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

	**Target 17: Biodiversity strategies and action plans** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.
	**Target 18: Traditional knowledge** By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.
	**Target 19: Sharing information and knowledge** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.
	**Target 20: Mobilizing resources from all sources** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

APPENDIX B

DRAFT POST-2020 GLOBAL BIODIVERSITY FRAMEWORK 2050 GOALS & 2030 ACTION TARGETS [234]

2050 Goals

Goal A The integrity of all ecosystems is enhanced, with an increase of at least 15 per cent in the area, connectivity and integrity of natural ecosystems, supporting healthy and resilient populations of all species, the rate of extinctions has been reduced at least tenfold, and the risk of species extinctions across all taxonomic and functional groups, is halved, and genetic diversity of wild and domesticated species is safeguarded, with at least 90 per cent of genetic diversity within all species maintained.
Goal B Nature's contributions to people are valued, maintained or enhanced through conservation and sustainable use supporting the global development agenda for the benefit of all;
Goal C The benefits from the utilization of genetic resources are shared fairly and equitably, with a substantial increase in both monetary and non-monetary benefits shared, including for the conservation and sustainable use of biodiversity.
Goal D The gap between available financial and other means of implementation, and those necessary to achieve the 2050 Vision, is closed.

2030 action targets

1. Reducing threats to biodiversity

Target 1	Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas.
Target 2	Ensure that at least 20 per cent of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems.
Target 3	Ensure that at least 30 per cent globally of land areas and of sea areas, especially areas of particular importance for biodiversity and its contributions to people, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
Target 4	Ensure active management actions to enable the recovery and conservation of species and the genetic diversity of wild and domesticated species, including through ex situ conservation, and effectively manage human-wildlife interactions to avoid or reduce human-wildlife conflict.
Target 5	Ensure that the harvesting, trade and use of wild species is sustainable, legal, and safe for human health.
Target 6	Manage pathways for the introduction of invasive alien species, preventing, or reducing their rate of introduction and establishment by at least 50 per cent, and control or eradicate invasive alien species to eliminate or reduce their impacts, focusing on priority species and priority sites.
Target 7	Reduce pollution from all sources to levels that are not harmful to biodiversity and ecosystem functions and human health, including by reducing nutrients lost to the environment by at least half, and pesticides by at least two thirds and eliminating the discharge of plastic waste.
Target 8	Minimize the impact of climate change on biodiversity, contribute to mitigation and adaptation

[234] Convention on Biological Diversity (CBD). (July 2021). "First Draft of the Post-2020 Global Biodiversity Framework."

	through ecosystem-based approaches, contributing at least 10 GtCO2e per year to global mitigation efforts, and ensure that all mitigation and adaptation efforts avoid negative impacts on biodiversity.

2. Meeting people's needs through sustainable use and benefit-sharing

Target 9	Ensure benefits, including nutrition, food security, medicines, and livelihoods for people especially for the most vulnerable through sustainable management of wild terrestrial, freshwater and marine species and protecting customary sustainable use by indigenous peoples and local communities.
Target 10	Ensure all areas under agriculture, aquaculture and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems.
Target 11	Maintain and enhance nature's contributions to regulation of air quality, quality and quantity of water, and protection from hazards and extreme events for all people.
Target 12	Increase the area of, access to, and benefits from green and blue spaces, for human health and well-being in urban areas and other densely populated areas.
Target 13	Implement measures at global level and in all countries to facilitate access to genetic resources and to ensure the fair and equitable sharing of benefits arising from the use of genetic resources, and as relevant, of associated traditional knowledge, including through mutually agreed terms and prior and informed consent.

3. Tools and solutions for implementation and mainstreaming

Target 14	Fully integrate biodiversity values into policies, regulations, planning, development processes, poverty reduction strategies, accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy, ensuring that all activities and financial flows are aligned with biodiversity values.
Target 15	All businesses (public and private, large, medium and small) assess and report on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, by at least half and increase positive impacts, reducing biodiversity-related risks to businesses and moving towards the full sustainability of extraction and production practices, sourcing and supply chains, and use and disposal.
Target 16	Ensure that people are encouraged and enabled to make responsible choices and have access to relevant information and alternatives, taking into account cultural preferences, to reduce by at least half the waste and, where relevant the overconsumption, of food and other materials.
Target 17	Establish, strengthen capacity for, and implement measures in all countries to prevent, manage or control potential adverse impacts of biotechnology on biodiversity and human health, reducing the risk of these impacts.
Target 18	Redirect, repurpose, reform or eliminate incentives harmful for biodiversity, in a just and equitable way, reducing them by at least US$ 500 billion per year, including all of the most harmful subsidies, and ensure that incentives, including public and private economic and regulatory incentives, are either positive or neutral for biodiversity.
Target 19	Increase financial resources from all sources to at least US$ 200 billion per year, including new, additional and effective financial resources, increasing by at least US$ 10 billion per year international financial flows to developing countries, leveraging private finance, and increasing domestic resource mobilization, taking into account national biodiversity finance planning, and strengthen capacity-building and technology transfer and scientific cooperation, to meet the needs for implementation, commensurate with the ambition of the goals and targets of the framework.
Target 20	Ensure that relevant knowledge, including the traditional knowledge, innovations and practices of indigenous peoples and local communities with their free, prior, and informed consent, guides decision-making for the effective management of biodiversity, enabling monitoring, and by promoting awareness, education and research.
Target 21	Ensure equitable and effective participation in decision-making related to biodiversity by indigenous peoples and local communities, and respect their rights over lands, territories and resources, as well as by women and girls, and youth.

APPENDIX C

WEF-IBC

	Themes	Metrics and disclosures	
WEF	**Nature loss**	**Land use and ecological sensitivity (core metric)**	Report the number and area (in hectares) of sites owned, leased or managed in or adjacent to protected areas and/or key biodiversity areas (KBA). (source: GRI 304-1) Alongside this disclosure, companies may wish to share information on the measures in place to ensure effective stewardship of these sites.
		Land use and ecological sensitivity (expanded metric)	Report for operations (if applicable) and full supply chain (if material): 4. Area of land used for the production of basic plant, animal or mineral commodities (e.g. the area of land used for forestry, agriculture or mining activities). 5. Year-on-year change in the area of land used for the production of basic plant, animal or mineral commodities. Note: Supply-chain figures can initially be estimated where necessary based on the mass of each commodity used and the average mass produced per unit of land in different sourcing locations. 6. Percentage of land area in point 1 above or of total plant, animal and mineral commodity inputs by mass or cost, covered by a sustainability certification standard or formalized sustainable management program. Disclose the certification standards or description of sustainable management programs along with the percentage of total land area, mass or cost covered by each certification standard/program.
		Impact of land use and conversion (expanded metric)	Report wherever material along the value chain: the valued impact of use of land and conversion of ecosystems. (source: Natural Capital Protocol (2016)/ ISO 14008 Monetary valuation of environmental impacts and related environmental aspects (2019) / Value Balancing Alliance)[235]
	Climate change	**Greenhouse gas (GHG) emissions**	For all relevant greenhouse gases (e.g. carbon dioxide, methane, nitrous oxide, F-gases etc.), report in metric tons of carbon dioxide equivalent (tCO2e) GHG Protocol Scope 1 and Scope 2 emissions. Estimate and report material upstream and downstream (GHG Protocol Scope 3) emissions where appropriate.
		Paris-aligned GHG emissions targets	Define and report progress against time-bound science-based GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C. This should include defining a date before 2050 by which you will achieve net-zero greenhouse gas emissions, and interim reduction targets based on the methodologies provided by the Science Based Targets initiative, if applicable. If an alternative approach is taken, disclose the methodology used to calculate the targets and the basis on which they deliver on the goals of the Paris Agreement.
	Freshwater availability	**Water consumption and withdrawal in water-stressed areas**	Report for operations where material: megalitres of water withdrawn, megalitres of water consumed and the percentage of each in regions with high or extremely high baseline water stress, according to WRI Aqueduct water risk atlas tool. Estimate and report the same information for the full value chain

[235] Reporting valued impact in monetary terms provides a meaningful indication of the scale of impacts in units that can be readily understood by executives and compared across impact areas and with financial figures. Valuation of environmental impacts is increasingly recognized as the most efficient and effective way of incorporating as much relevant contextual information as possible to provide estimates of actual impact, rather than simply measures of output as is the case with most quantitative environmental metrics.

			(upstream and downstream) where appropriate.
		Impact of freshwater consumption and withdrawal	Report wherever material along the value chain: the valued impact of freshwater consumption and withdrawal.
	Air pollution	**Air pollution**	Report wherever material along the value chain: nitrogen oxides (NOx), sulphur oxides (SOx), particulate matter and other significant air emissions. Wherever possible estimate the proportion of specified emissions that occur in or adjacent to urban/densely populated areas.
		Impact of air pollution	Report wherever material along the value chain: the valued impact of air pollution, including nitrogen oxides (NOx), sulphur oxides (SOx), particulate matter and other significant air emissions.
	Water pollution	**Nutrients**	Estimate and report wherever material along the value chain: metric tons of nitrogen, phosphorous and potassium in fertilizer consumed.
		Impact of water pollution	Report wherever material along the value chain: the valued impact of water pollution, including excess nutrients, heavy metals and other toxins.
	Solid waste	**Single-use plastics**	Report wherever material along the value chain: estimated metric tons of single-use plastic consumed. Disclose the most significant applications of single-use plastic identified, the quantification approach used and the definition of single-use plastic adopted.
		Impact of solid waste disposal	Report wherever material along the value chain, the valued societal impact of solid waste disposal, including plastics and other waste streams.
	Resource availability	**Resource circularity**	Report the most appropriate resource circularity metric(s) for the whole company and/or at a product, material or site level as applicable. Potential metrics include (but are not limited to) the Circular Transition Indicators (WBCSD), indicators developed by the Ellen MacArthur Foundation and company developed metrics. Disclose the methodological approach used to calculate the chosen circularity metric(s) and the rationale for the choice of metric(s).
	Risk and opportunity oversight	**Integrating risk and opportunity into business process**	Company risk factor and opportunity disclosures that clearly identify the principal material risks and opportunities facing the company specifically (as opposed to generic sector risks), the company appetite in respect of these risks, how these risks and opportunities have moved over time and the response to those changes. These opportunities and risks should integrate material economic, environmental and social issues, including climate change and data stewardship.
		Economic, environmental and social topics in capital allocation framework	How the highest governance body considers economic, environmental and social issues when overseeing major capital allocation decisions, such as expenditures, acquisitions and divestments.

GRI

	Topics	Disclosures	Reporting requirements
GRI	**Biodiversity**	**304-1 Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas**	a. For each operational site owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas, the following information: i. Geographic location; ii. Subsurface and underground land that may be owned, leased, or managed by the organization; iii. Position in relation to the protected area (in the area, adjacent to, or containing portions of the protected area) or the high biodiversity value area outside protected areas; iv. Type of operation (office, manufacturing or production, or extractive);

			v. Size of operational site in km2 (or another unit, if appropriate); vi. Biodiversity value characterized by the attribute of the protected area or area of high biodiversity value outside the protected area (terrestrial, freshwater, or maritime ecosystem); vii. Biodiversity value characterized by listing of protected status (such as IUCN Protected Area Management Categories, Ramsar Convention, national legislation).
		304-2 Significant impacts of activities, products, and services on biodiversity	a. Nature of significant direct and indirect impacts on biodiversity with reference to one or more of the following: i. Construction or use of manufacturing plants, mines, and transport infrastructure; ii. Pollution (introduction of substances that do not naturally occur in the habitat from point and non-point sources); iii. Introduction of invasive species, pests, and pathogens; iv. Reduction of species; v. Habitat conversion; vi. Changes in ecological processes outside the natural range of variation (such as salinity or changes in groundwater level). b. Significant direct and indirect positive and negative impacts with reference to the following: i. Species affected; ii. Extent of areas impacted; iii. Duration of impacts; iv. Reversibility or irreversibility of the impacts.
		304-3 Habitats protected or restored	a. Size and location of all habitat areas protected or restored, and whether the success of the restoration measure was or is approved by independent external professionals. b. Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures. c. Status of each area based on its condition at the close of the reporting period. d. Standards, methodologies, and assumptions used.
		304-4 IUCN Red List species and national conservation list species with habitats in areas affected by operations	a. Total number of IUCN Red List species and national conservation list species with habitats in areas affected by the operations of the organization, by level of extinction risk: i. Critically endangered ii. Endangered iii. Vulnerable iv. Near threatened v. Least concern
	Environmental Compliance	**307-1 Non-compliance with environmental laws and regulations**	a. Significant fines and non-monetary sanctions for non-compliance with environmental laws and/or regulations in terms of: i. total monetary value of significant fines; ii. total number of non-monetary sanctions; iii. cases brought through dispute resolution mechanisms. b. If the organization has not identified any non-compliance with environmental laws and/or regulations, a brief statement of this fact is sufficient.
	Supplier Environmental Assessment	**308-1 New suppliers that were screened using environmental criteria**	a. Percentage of new suppliers that were screened using environmental criteria.
		308-2 Negative environmental impacts in the supply chain and actions taken	a. Number of suppliers assessed for environmental impacts. b. Number of suppliers identified as having significant actual and potential negative environmental impacts. c. Significant actual and potential negative environmental impacts identified in the supply chain.

			d. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which improvements were agreed upon as a result of assessment. e. Percentage of suppliers identified as having significant actual and potential negative environmental impacts with which relationships were terminated as a result of assessment, and why.
	Materials	**301-1 Materials used by weight or volume**	Total weight or volume of materials that are used to produce and package the organization's primary products and services during the reporting period, by: i. non-renewable materials used; ii. renewable materials used.
		301-2 Recycled input materials used	Percentage of recycled input materials used to manufacture the organization's primary products and services.
		301-3 Reclaimed products and their packaging materials	a. Percentage of reclaimed products and their packaging materials for each product category. b. How the data for this disclosure have been collected.
	Water and Effluents	**303-1 Interactions with water as a shared resource**	a. A description of how the organization interacts with water, including how and where water is withdrawn, consumed, and discharged, and the water-related impacts caused or contributed to, or directly linked to the organization's activities, products or services by a business relationship (e.g., impacts caused by runoff). b. A description of the approach used to identify water-related impacts, including the scope of assessments, their timeframe, and any tools or methodologies used. c. A description of how water-related impacts are addressed, including how the organization works with stakeholders to steward water as a shared resource, and how it engages with suppliers or customers with significant water-related impacts. d. An explanation of the process for setting any water-related goals and targets that are part of the organization's management approach, and how they relate to public policy and the local context of each area with water stress.
		303-2 Management of water discharge-related impacts	A description of any minimum standards set for the quality of effluent discharge, and how these minimum standards were determined, including: i. how standards for facilities operating in locations with no local discharge requirements were determined; ii. any internally developed water quality standards or guidelines; iii. any sector-specific standards considered; iv. whether the profile of the receiving waterbody was considered.
		303-3 Water withdrawal	a. Total water withdrawal from all areas in megaliters, and a breakdown of this total by the following sources, if applicable: i. Surface water; ii. Groundwater; iii. Seawater; iv. Produced water; v. Third-party water. b. Total water withdrawal from all areas with water stress in megaliters, and a breakdown of this total by the following sources, if applicable: i. Surface water; ii. Groundwater; iii. Seawater; iv. Produced water; v. Third-party water, and a breakdown of this total by the withdrawal sources listed in i-iv. c. A breakdown of total water withdrawal from each of the sources listed in Disclosures 303-3-a and 303-3-b in megaliters by the following categories: i. Freshwater (≤1,000 mg/L Total Dissolved Solids); ii. Other water (>1,000 mg/L Total Dissolved Solids). d. Any contextual information necessary to understand how the data have been compiled, such as any standards, methodologies, and assumptions used.
		303-4 Water discharge	a. Total water discharge to all areas in megaliters, and a breakdown of this total by the following types of destination, if applicable: i. Surface water; ii. Groundwater; iii. Seawater; iv. Third-party water, and the volume of this total sent for use to other organizations, if applicable. b. A breakdown of total water discharge to all areas in megaliters by the following categories: i. Freshwater (≤1,000 mg/L Total Dissolved Solids); ii. Other water (>1,000 mg/L Total Dissolved Solids). c. Total water discharge to all areas with water stress in megaliters, and a breakdown of this total by the following categories:

			i. Freshwater (≤1,000 mg/L Total Dissolved Solids); ii. Other water (>1,000 mg/L Total Dissolved Solids). d. Priority substances of concern for which discharges are treated, including: i. how priority substances of concern were defined, and any international standard, authoritative list, or criteria used; ii. the approach for setting discharge limits for priority substances of concern; iii. number of incidents of non-compliance with discharge limits. e. Any contextual information necessary to understand how the data have been compiled, such as any standards, methodologies, and assumptions used.
		Water consumption	a. Total water consumption from all areas in megaliters. b. Total water consumption from all areas with water stress in megaliters. c. Change in water storage in megaliters, if water storage has been identified as having a significant water-related impact. d. Any contextual information necessary to understand how the data have been compiled, such as any standards, methodologies, and assumptions used, including whether the information is calculated, estimated, modeled, or sourced from direct measurements, and the approach taken for this, such as the use of any sector-specific factors.
	Emissions	**305-1 Direct (Scope 1) GHG emissions**	a. Gross direct (Scope 1) GHG emissions in metric tons of CO2 equivalent. b. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. c. Biogenic CO2 emissions in metric tons of CO2 equivalent. d. Base year for the calculation, if applicable, including: i. the rationale for choosing it; ii. emissions in the base year; iii. the context for any significant changes in emissions that triggered recalculations of base year emissions. e. Source of the emission factors and the global warming potential (GWP) rates used, or a reference to the GWP source. f. Consolidation approach for emissions; whether equity share, financial control, or operational control. g. Standards, methodologies, assumptions, and/or calculation tools used.
		305-2 Energy indirect (Scope 2) GHG emissions	a. Gross location-based energy indirect (Scope 2) GHG emissions in metric tons of CO2 equivalent. b. If applicable, gross market-based energy indirect (Scope 2) GHG emissions in metric tons of CO2 equivalent. c. If available, the gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. d. Base year for the calculation, if applicable, including: i. the rationale for choosing it; ii. emissions in the base year;iii. the context for any significant changes in emissions that triggered recalculations of base year emissions. e. Source of the emission factors and the global warming potential (GWP) rates used, or a reference to the GWP source. f. Consolidation approach for emissions; whether equity share, financial control, or operational control. g. Standards, methodologies, assumptions, and/or calculation tools used.
		305-3 Other indirect (Scope 3) GHG emissions	a. Gross other indirect (Scope 3) GHG emissions in metric tons of CO2 equivalent. b. If available, the gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. c. Biogenic CO2 emissions in metric tons of CO2 equivalent. d. Other indirect (Scope 3) GHG emissions categories and activities included in the calculation. e. Base year for the calculation, if applicable, including: i. the rationale for choosing it; ii. emissions in the base year; iii. the context for any significant changes in emissions that triggered recalculations of base year emissions. f. Source of the emission factors and the global warming potential (GWP) rates used, or a reference to the GWP source. g. Standards, methodologies, assumptions, and/or calculation tools used.

		305-4 GHG emissions intensity	a. GHG emissions intensity ratio for the organization. b. Organization-specific metric (the denominator) chosen to calculate the ratio. c. Types of GHG emissions included in the intensity ratio; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). d. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all.
		305-5 Reduction of GHG emissions	a. GHG emissions reduced as a direct result of reduction initiatives, in metric tons of CO2 equivalent. b. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. c. Base year or baseline, including the rationale for choosing it. d. Scopes in which reductions took place; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). e. Standards, methodologies, assumptions, and/or calculation tools used.
		305-6 Emissions of ozone-depleting substances (ODS)	a. Production, imports, and exports of ODS in metric tons of CFC-11 (trichlorofluoromethane) equivalent. b. Substances included in the calculation. c. Source of the emission factors used. d. Standards, methodologies, assumptions, and/or calculation tools used.
		305-7 Nitrogen oxides (NOX), sulfur oxides (SOX), and other significant air emissions	a. Significant air emissions, in kilograms or multiples, for each of the following: i. NOX; ii. SOX; iii. Persistent organic pollutants (POP); iv. Volatile organic compounds (VOC); v. Hazardous air pollutants (HAP); vi. Particulate matter (PM); vii. Other standard categories of air emissions identified in relevant regulations b. Source of the emission factors used. c. Standards, methodologies, assumptions, and/or calculation tools used.
	Waste	**306-1 Waste generation and significant waste-related impacts**	a. For the organization's significant actual and potential waste-related impacts, a description of: i. the inputs, activities, and outputs that lead or could lead to these impacts; ii. whether these impacts relate to waste generated in the organization's own activities or to waste generated upstream or downstream in its value chain.
		306-2 Management of significant waste-related impacts	a. Actions, including circularity measures, taken to prevent waste generation in the organization's own activities and upstream and downstream in its value chain, and to manage significant impacts from waste generated. b. If the waste generated by the organization in its own activities is managed by a third party, a description of the processes used to determine whether the third party manages the waste in line with contractual or legislative obligations. c. The processes used to collect and monitor waste-related data.
		306-3 Waste generated	a. Total weight of waste generated in metric tons, and a breakdown of this total by composition of the waste. b. Contextual information necessary to understand the data and how the data has been compiled
		306-4 Waste diverted from disposal	a. Total weight of waste diverted from disposal in metric tons, and a breakdown of this total by composition of the waste. b. Total weight of hazardous waste diverted from disposal in metric tons, and a breakdown of this total by the following recovery operations: i. Preparation for reuse; ii. Recycling; iii. Other recovery operations. c. Total weight of non-hazardous waste diverted from disposal in metric tons, and a breakdown of this total by the following recovery operations: i. Preparation for reuse; ii. Recycling; iii. Other recovery operations. d. For each recovery operation listed in Disclosures 306-4-b and 306-4-c, a breakdown of the total weight in metric tons of hazardous waste and of non-hazardous waste diverted from disposal: i. onsite; ii. offsite. e. Contextual information necessary to understand the data and how the data has been compiled.
		306-5 Waste directed to disposal	a. Total weight of waste directed to disposal in metric tons, and a breakdown of this total by composition of the waste.

			b. Total weight of hazardous waste directed to disposal in metric tons, and a breakdown of this total by the following disposal operations: i. Incineration (with energy recovery); ii. Incineration (without energy recovery); iii. Landfilling; iv. Other disposal operations. c. Total weight of non-hazardous waste directed to disposal in metric tons, and a breakdown of this total by the following disposal operations: i. Incineration (with energy recovery); ii. Incineration (without energy recovery); iii. Landfilling; iv. Other disposal operations. d. For each disposal operation listed in Disclosures 306-5-b and 306-5-c, a breakdown of the total weight in metric tons of hazardous waste and of non-hazardous waste directed to disposal: i. onsite; ii. offsite. e. Contextual information necessary to understand the data and how the data has been compiled.

SASB

	General issue category	Disclosure topics	Accounting metrics
SASB	**Ecological Impacts**[236]	**Environmental impacts of project development**	Number of incidents of non-compliance with environmental permits, standards, and regulations
			Discussion of processes to assess and manage environmental risks associated with project design, siting, and construction
			Number and duration of project delays related to ecological impacts
			Description of efforts in (solar energy system) project development to address community and ecological impacts
		Biodiversity impacts	Terrestrial acreage disturbed, percentage of impacted area restored
			Percentage of engines in service that meet Tier 4 compliance for non-road diesel engine emissions
		Land use & Ecological impacts	Number of (1)lots and (2) homes delivered on redevelopment sites (in Home builders)
			Total amount of monetary losses as a result of legal proceedings associated with environmental regulations
	Product Design & Lifecycle Management	**Product End-of- life Management**	Percentage of materials with recycled content
			Weight of end-of-life material recovered, percentage recycled
			Description of approach and strategies to design products for high-value recycling
			Description of approach to manage use, reclamation, and disposal of hazardous materials
		Ecological Impacts of Project Development	(for wind energy projects) Average A-weighted sound power level of wind turbines, by wind turbine class
			(for wind energy projects) Backlog cancellations associated with community or ecological impacts
			(for wind energy projects) Description of efforts to address ecological and community impacts of wind energy production through turbine design
	Supply Chain Management	**Supply Chain Management**	Discussion of strategy to manage environmental and social risks arising from the supply chain
		Environmental & Social Impacts of supply chain	Percentage of [materials] sourced that are certified to a third-party environmental and/or social standard, and percentages by standard
			Suppliers' social and environmental responsibility audit (1) non-

[236] Ecological Impacts: The category addresses management of company's impacts on ecosystems and biodiversity through activities including, but not limited to, land use for exploration, natural resource extraction, and cultivation, as well as project development, construction, and siting. The impacts include, but not limited to, biodiversity loss, habitat destruction, and deforestation at all stages- planning, land acquisition, permitting, development, operations and site remediation. The category does not cover impacts of climate change on ecosystems and biodiversity.

			conformance rate and (2) associated corrective action rate for (a) major and (b) minor conformances
			Discussion of strategy to mange environmental and social risks arising from contract growing and commodity sourcing
	Materials Sourcing & Efficiency	**Water Supply Resilience**	Total water sourced from regions with High or Extremely High Baseline Water Stress, percentage purchased from a third party
			Volume of recycled water delivered to customers
			Discussion of strategies to manage risks associated with the quality and availability of water resources
		Material Sourcing	Description of environmental and social risks associated with sourcing priority raw materials
	GHG Emissions	**Greenhouse emissions**	Gross global Scope 1 emissions and percentage of Scope 1 emissions emitted in areas that are subject to emissions-limiting or emissions-reporting regulation
			Percentage of of Scope 1 emissions associated with the emission of a specific (per industry) substance
			Discussion of long-term and short-term strategy or plan to manage Scope 1 and lifecycle emissions, emissions reduction targets, and an analysis of performance against those targets
			(1) Total landfill gas generated (2) percentage flared (3) percentage used for energy
		Emissions Reduction Services & Fuels management	Total fuel consumed; percentage renewable; percentage used in: (1) on-road equipment and vehicles (2) off-road equipment
			Discussion of strategies or plans to address air-emissions related risks, opportunities and impacts
			Percentage of engines in service that meet Tier 4 compliance for non-road diesel engine emissions
		Fleet fuel management	Fleet fuel consumed (2) percentage natural gas, (3) percentage renewable
			Percentage of alternative fuel vehicles in fleet
	Air quality	**Air quality**	Air emissions of the following pollutants: (1) NOx (excluding N2O), (2) SOx, (3) particulate matter (PM10),volatile organic compounds (VOCs), and (4) hazardous air pollutants (HAPs); percentage of each in or near areas of dense population
			Number of incidents of non-compliance associated with air emissions
	Water & Wastewater Management	**Water Management**	(1) Total water withdrawn, (2) total water consumed, percentage of each in regions with High or Extremely High Baseline Water Stress
			Number of incidents of non-compliance associated with water quantity and/or quality permits, standards, and regulations
			Description of water management risks and discussion of strategies and practices to mitigate those risks
		Effluent Quality Management	Number of incidents of non-compliance associated with water effluent quality permits, standards, and regulations
			Discussion of strategies to manage effluents of emerging concern
	Waste & Hazardous Materials Management	**Waste management**	Amount of waste generated, percentage hazardous, percentage recycled
		Coal ash management	Amount of coal combustion residuals (CCR) generated, percentage recycled
			Total number of coal combustion residual (CCR) impoundments, broken down by hazard potential classification and structural integrity assessment
		Management of Leachate & Hazardous Waste	(1) Total Toxic Release Inventory (TRI) releases, (2) percentage released to water
			Number of corrective actions implemented for landfill releases
			Number of incidents of non-compliance associated with environmental impacts
		Hazardous Waste Management	Amount of hazardous waste generated, percentage recycled
			Number and aggregate quantity of reportable spills, quantity recovered

GRESB

	Aspects	Performance Indicators	Metrics
GRESB	**Biodiversity & habitat**[237]	**Biodiversity & habitat**	Wildlife fatalities
			Threatened & Endangered **(**T&E)[238] species fatalities
			Habitat removed
			Habitat enhanced or restored
			Habitat protected (on-site)
			Habitat protected (off-site)
			Net habitat gain = "Habitat enhanced or restored" + "Habitat protected (on-site)" + "Habitat protected (off-site)" - "Habitat removed"
			Habitat maintained
			Habitat gain intensity (per GAV; per revenue/ per output)
	GRESB requests evidence that the reported data has been subject of external review of by an independent third party and lists a series of schemes.		
	Greenhouse gas emissions	**Greenhouse gas emissions**	Emissions from combustion of fuels
			Process emissions
			Fugitive emissions
			Total scope 1 emissions ("Emissions from combustion of fuels" + "Process emissions" + "Fugitive emissions")
			Total scope 1+2 emissions
			Total scope 1,2+3 emissions
			On-site offsets
			Offsets purchased
			Net GHG emissions (scope 1+2) = "Total scope 1 + 2" - ("On-site offsets" + "Offsets purchased")
			Net GHG emissions (scope 1,2+3) = "Total scope 1,2 + 3" - ("On-site offsets" + "Offsets purchased")
			Emissions avoided (export of renewable energy) (emissions avoided through generation of renewable energy on site and exported off-site (sold) to customers. They can be calculated by multiplying the amount of renewable energy exported with the emission factor for the grid, or using other tools available in the market.
			Gross GHG emissions intensity (per GAV; per revenue/ per output)
			Net GHG emissions intensity (per GAV; per revenue/ per output)
		Scope 3 GHG emissions	Scope 3 GHG emissions reporting per source: • Purchased goods and services • Capital goods • Fuel- and energy-related activities • Upstream transportation and distribution • Waste generated in operations • Business travel • Employee commuting • Upstream leased assets • Downstream transportation and distribution • Processing of sold products • Use of sold products • End-of-life treatment of sold products • Downstream leased assets • Franchises • investments

[237] 2021 Asset Assessment, same in the 2022 Asset Assessment Prelease

[238] Animal and plant species that are either on the IUCN Red list, or have been designated as threatened, endangered, or protected, by local or national governments.

		Scope 2 GHG emissions	Indicating the approach used for calculation: • Location-based • Market-based • Mix of location- and market-based
		Science-based targets	Are any of the targets reported in the table above approved by the Science-Based Targets Initiative? Select the metric(s) for which the target has been approved by the SBTI. • Total scope 1 • Scope 2 Scope 3 • Total Scope 1+2 • Total scope 1+2+3 • Gross GHG emissions intensity ((per GAV; per revenue/ per output)
	Air pollution	**Air pollution**	Air pollution kg per type of air pollutant: SO_X; NO_X; PM2.5; PM10; Ozone (O_3);Lead (Pb); Mercury (Hg); Ozone-depleting substances
			No. of non-compliances
	Water	**Water inflows/ withdrawals**	Total Water withdrawals through a calculation of megaliters per type of source: • groundwater • rainwater • seawater/ brackish water • surface water • produced water • third-party non-potable water • third-party potable water
			% potable water of total water withdrawals (“Third-party potable water” / “Total water withdrawals” * 100)
			Total HWS withdrawals (All withdrawals from areas that have High or Extremely High Baseline Water Stress (HWS) as classified by the World Resources Institute's (WRI) Water Risk Atlas tool, Aqueduct)
			Water withdrawal intensity (per GAV; per revenue/ per output)
		Water outflows/ discharges	Quality of water discharged to sensitive waterways • Freshwater (<=1000mg/L TDS) • other water (>1000mg/L TDS) Reporting discharge per type of natural body of water: • Groundwater; • Seawater/brackish water; • Surface water
			Total discharge to sensitive waterways (subtotal of “Groundwater” + “Seawater/ brackish water” + “Surface water”)
			Total water discharged (“Groundwater” + “Seawater / brackish water” + “Surface water” + “Third-party re-use” + “Third-party treatment”)
			Total water re-used (“Third-party re-use” / “Total water discharged” * 100)
			No. of non-compliances
			Water discharge intensity (per GAV; per revenue/ per output)
	Waste	**Waste generated and disposed**	Tons of Hazardous waste generated
			Tons of non-hazardous waste generated
			Total waste disposed (tons per type of treatment): • Re-use • Recycling • Waste-to-energy • Incineration • Landfill • unknown
			Total waste diverted from landfill/ incineration (“Re-use” + “Recycling” + “Composting” + “Waste-to-energy”) / “Total waste disposed” * 100)
			Waste intensity (per GAV; per revenue/ per output)

APPENDIX D

MA classification of ecosystem services

Categories	Ecosystem Services	Description
Provisioning services	Food	
	freshwater	
	Fiber, timber	
	Genetic resources	Includes the genes and genetic information used for animal and plant breeding and biotechnology.
	Biochemicals	Biochemicals, natural medicines and pharmaceuticals. Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems.
	Ornamental resources	Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined. This is an example of linkages between the categories of ecosystem services.
Regulating services	Air quality regulation	Air quality maintenance. Ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality.
	Water purification and waste treatment	Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems.
	Water regulation	The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas.
	Erosion regulation	Vegetative cover plays an important role in soil retention and the prevention of landslides
	Climate regulation	Ecosystems influence climate both locally and globally. For example, at a local scale, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases.
	Pollination	Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators.
	Pest regulation	Biological control. Ecosystem changes affect the prevalence of crop and livestock pests and diseases.
	Disease regulation	Regulation of human diseases. Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes.
	Storm protection	The presence of coastal ecosystems such as mangroves and coral reefs can dramatically reduce the damage caused by hurricanes or large waves.
Supporting services	Soil formation	Humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production.
	Primary production	Assimilation (gross) or accumulation (net) of energy and nutrients by green plants and by organisms that use inorganic compounds as food.
	Production of atmospheric oxygen	Production of oxygen gas (through photosynthesis) is categorized as a supporting service since any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely

		long time
	Nutrient cycling	
	Water cycling	
	Provisioning of habitat	
Cultural services	Cultural diversity	The diversity of ecosystems is one factor influencing the diversity of cultures.
	Spiritual and religious values	Many religions attach spiritual and religious values to ecosystems or their components.
	Knowledge systems (traditional and formal)	Ecosystems influence the types of knowledge systems developed by different cultures.
	Educational values	Ecosystems and their components and processes provide the basis for both formal and informal education in many societies.
	Inspiration	Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.
	Aesthetic values	Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, "scenic drives," and the selection of housing locations.
	Social relations	Ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies.
	Sense of place	Many people value the "sense of place" that is associated with recognized features of their environment, including aspects of the ecosystem.
	Cultural heritage values	Many societies place high value on the maintenance of either historically important landscapes ("cultural landscapes") or culturally significant species.
	Recreation and ecotourism	Ecosystems and their components and processes provide the basis for both formal and informal education in many societies

De Groot et al. classification of ecosystem functions and services[239]

	FUNCTIONS	ECOSYSTEM PROCESSES & COMPONENTS	GOODS AND SERVICES (examples)
	Regulation Functions	*Maintenance of essential ecological processes and life support systems*	
1	Gas regulation	Role of ecosystems in bio-geochemical cycles (e.g. CO2/ O2 balance, ozone layer, etc.)	1.1 UVb-protection by O3 (preventing disease) 1.2 Maintenance of (good) air quality 1.3 Influence on climate (see also function 2.)
2	Climate regulation	Influence of land cover and biol. mediated processes (e.g. DMS-production) on climate	Maintenance of a favorable climate (temp., precipitation, etc) for, for example, human habitation, health, cultivation
3	Disturbance prevention	Influence of ecosystem structure on dampening env. disturbances	3.1 Storm protection (e.g. by coral reefs) 3.2 Flood prevention (e.g. by wetlands and forests)
4	Water regulation	Role of land cover in regulating runoff & river discharge	4.1 Drainage and natural irrigation 4.2 Medium for transport
5	Water supply	Filtering, retention and storage of fresh water (e.g. in aquifers)	Provision of water for consumptive use (e.g. drinking, irrigation and industrial use)
6	Soil retention	Role of vegetation root matrix and soil biota in soil retention	6.1 Maintenance of arable land 6.2 Prevention of damage from erosion/siltation
7	Soil formation	Weathering of rock, accumulation of organic matter	7.1 Maintenance of productivity on arable land 7.2 Maintenance of natural productive soils
8	Nutrient regulation	Role of biota in storage and re-cyling of nutrients (eg.N,P&S)	Maintenance of healthy soils and productive ecosystems
9	Waste treatment	Role of vegetation & biota in removal or breakdown of xenic nutrients and compounds	9.1 Pollution control/detoxification 9.2 Filtering of dust particles 9.3 Abatement of noise pollution
10	Pollination	Role of biota in movement of floral gametes	10.1 Pollination of wild plant species 10.2 Pollination of crops
11	Biological control	Population control through trophic-dynamic relations	11.1 Control of pests and diseases 11.2 Reduction of herbivory (crop damage)
	Habitat Functions	*Providing habitat (suitable living space) for wild plant and animal species*	
12	Refugium function	Suitable living space for wild plants and animals	Maintenance of biological & genetic diversity (and thus the basis for most other functions)
13	Nursery Function	Suitable reproduction habitat	Maintenance of commercially harvested species
	Production Functions	*Provision of natural resources*	
14	Food	Conversion of solar energy into edible plants and animals	14.1 Hunting, gathering of fish, game, fruits, etc. 14.2 Small-scale subsistence farming & aquaculture
15	Raw materials	Conversion of solar energy into biomass for human construction and other uses	15.1 Building & Manufacturing (e.g. lumber, skins) 15.2 Fuel and energy (e.g. fuel wood, organic matter) 15.3 Fodder and fertilizer (e.g. krill, leaves, litter).
16	Genetic resources	Genetic material and evolution in wild plants and animals	16.1 Improve crop resistance to pathogens & pests, 16.2 Other applications (e.g. health care)
17	Medicinal resources	Variety in (bio)chemical sub-stances in, and other medicinal uses of, natural biota	17.1 Drugs and pharmaceuticals 17.2 Chemical models & tools 17.3 Test- and essay organisms
18	Ornamental resources	Variety of biota in natural ecosystems with (potential) ornamental use	Resources for fashion, handicraft, jewelry, pets, worship, decoration & souvenirs (e.g. furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)
	Information Functions	*Providing opportunities for cognitive development*	
19	Aesthetic information	Attractive landscape features	Enjoyment of scenery (scenic roads, housing , etc.)
20	Recreation	Variety in landscapes with (potential) recreational uses	Travel to natural ecosystems for eco-tourism, outdoor sports, etc.
21	Cultural & artistic information	Variety in natural features with cultural and artistic value	Use of nature as motive in books, film, painting, folklore, national symbols, architect., advertising, etc
22	Spiritual and historic information	Variety in natural features with spiritual and historic value	Use of nature for religious or historic purposes (i.e. heritage value of natural ecosystems and features)
23	Science & Education	Variety in nature with scientific and educational value	Use of natural systems for school excursions, etc. Use of nature for scientific research

[239] De Groot, R., Wilson A., M. and Boumans, M.J., R. (June 2002). "A typology for the classification, description and valuation of ecosystem functions, goods and services." *Ecological Economics* Volume 41, Issue 3, Pages 393-408 (Special Issue on "The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives")

TEEB classification of ecosystem services (revised)[240]

Categories of Ecosystem services		Ecosystem services		ecosystem sub-services
Provisioning services	**1**	Food	1.1	Fish
			1.2	Meat
			1.3	Plants/ vegetable food
			1.4	NTFPs (food)
			1.5	Food (unspecified)
			1.6	Other
	2	Water	2.1	Drinking water
			2.2	Industrial water
			2.3	Water other
			2.4	Irrigation water (unnatural)
			2.5	water (unspecified)
	3	Raw Materials	3.1	Fibers
			3.2	Timber
			3.3	Fuel wood and charcoal
			3.4	Fodder
			3.5	Fertilizer
			3.6	Other raw
			3.7	Raw materials (unspecified)
			3.8	Sand, rock, gravel
			3.9	Biomass fuels
	4	Genetic resources	4.1	Plant genetic resources
			4.2	Animal genetic resources
			4.3	Genetic resources (unspecified)
	5	Medicinal resources	5.1	Bio-chemicals
			5.2	Models
			5.3	Test-organisms
			5.4	Bio-prospecting
	6	Ornamental resources	6.1	Decorative plants
			6.2	Fashion
			6.3	Decorations/ Handicrafts
			6.4	Pets and captive animals
Regulating services	**7**	Air quality regulation	7.1	Capturing fine dust
			7.2	Air quality regulation (unspecified)

[240] De Groot, R., Brander, L. and Solomonides, S. (June 2020). "Ecosystem Services Valuation Database (ESVD): Update of global ecosystem service valuation data. Final report". Prepared on behalf of the Department for Environment, Food and Rural Affairs (DEFRA, UK).

			7.3	UVb-protection
	8	Climate regulation (incl. C-sequestration)	8.1	Carbon sequestration
			8.2	MDS[241]-production
			8.3	Climate regulation (unspecified)
			8.4	Microclimate regulation
			8.5	Gas regulation
	9	Moderation of extreme events	9.1	Storm protection
			9.2	Flood protection
			9.3	Fire protection
			9.4	Prevention of extreme events (unspecified)
	10	Regulation of water flows	10.1	Drainage
			10.2	River discharge
			10.3	Natural irrigation
			10.4	Water regulation (unspecified)
	11	Waste treatment (incl. water purification)	11.1	Water purification
			11.2	Soil detoxication
			11.3	Abatement of noise
			11.4	Waste treatment (unspecified)
	12	Erosion prevention	12.1	Erosion prevention
	13	Maintenance of soil fertility	13.1	Maintenance of soil structure
			13.2	Deposition of nutrients
			13.3	Soil formation
			13.4	Nutrient cycling
	14	Pollination	14.1	Pollination of crops
			14.2	Pollination of wild plants
			14.3	Pollination (unspecified)
	15	Biological control	15.1	Seed dispersal
			15.2	Pest control
			15.3	Disease control
			15.4	Biological control (unspecified)
Habitat services	**16**	Maintenance of life cycles of migratory species (incl. nursery service)	16.1	Nursery service
			16.2	Refugia for migratory and resident species
	17	Maintenance of genetic diversity (especially in gene pool protection)	17.1	Biodiversity protection
Cultural & Amenity services	**18**	Aesthetic information	18.1	Attractive landscapes
	19	Opportunities for recreation and tourism	19.1	Recreation
			19.2	Tourism
			19.3	Ecotourism
			19.4	Hunting/ fishing

[241] Marginal Distribution Sampling (MDS)

	20	Inspiration for culture, art and design	20.1	Artistic inspiration
			20.2	Cultural use
			20.3	Inspiration (unspecified)
	21	Spiritual experience	21.1	spiritual/religious use
	22	Information for cognitive development	22.1	Science/research
			22.2	Education
			22.3	Cognitive/unspecified
	23	Existence, bequest values	23.1	Existence value
			23.2	Bequest value

CICES classification of ecosystem services[242]

Section	Division	Group	Class	Class type
Provisioning (Biotic)	Biomass	Cultivated terrestrial plants for nutrition, materials or energy	Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes	*Crops by amount, type (e.g. cereals, root crops, soft fruit, etc.)*
			Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	*Material by amount, type, use, media (land, soil, freshwater, marine)*
			Cultivated plants (including fungi, algae) grown as a source of energy	*By amount, type, source*
		Cultivated aquatic plants for nutrition, materials or energy	Plants cultivated by in- situ aquaculture grown for nutritional purposes	*Plants, algae by amount, type*
			Fibres and other materials from in-situ aquaculture for direct use or processing (excluding genetic materials)	*Plants, algae by amount, type*
			Plants cultivated by in- situ aquaculture grown as an energy source	*Plants, algae by amount, type*
		Reared animals for nutrition, materials or energy	Animals reared for nutritional purposes	*Animals, products by amount, type (e.g. beef, dairy)*
			Fibres and other materials from reared animals for direct use or processing (excluding genetic materials)	*Material by amount, type, use, media (land, soil, freshwater, marine)*
			Animals reared to provide energy (including mechanical)	*By amount, type, source*
		Reared aquatic animals for nutrition, materials or energy	Animals reared by in-situ aquaculture for nutritional purposes	*Animals by amount, type*
			Fibres and other materials from animals grown by in-situ aquaculture for direct use or processing (excluding genetic materials)	*Animals by amount, type*
			Animals reared by in-situ aquaculture as an energy source	*Animals by amount, type*
		Wild plants (terrestrial and aquatic) for nutrition, materials or energy	Wild plants (terrestrial and aquatic, including fungi, algae) used for nutrition	*Plants, algae by amount, type*
			Fibres and other materials from wild plants for direct use or processing (excluding genetic materials)	*Plants, algae by amount, type*
			Wild plants (terrestrial and aquatic, including fungi, algae) used as a source of energy	*Material by type/source*
			Wild animals (terrestrial and aquatic) used for nutritional purposes	*Animals by amount, type*
			Fibres and other materials from wild animals for direct use or processing (excluding genetic materials)	*Material by type/source*
			Wild animals (terrestrial and aquatic) used as a source of energy	*By amount, type, source*
	Genetic material from all biota (including seed, spore or gamete production)	Genetic material from plants, algae or fungi	Seeds, spores and other plant materials collected for maintaining or establishing a	*By species or varieties*
			Higher and lower plants (whole organisms) used to breed new strains or varieties	*By species or varieties*
			Individual genes extracted from higher and lower plants for the design and construction of new biological entities	*Material by type*
		Genetic material from animals	Animal material collected for the purposes of maintaining or establishing a population	*By species or varieties*
			Wild animals (whole organisms) used to breed new strains or varieties	*By species or varieties*
		Genetic material from organisms	Individual genes extracted from organisms for the design and construction of new biological entities	*Material by type*
	Other types of provisioning service from biotic sources	Other	Other	
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Surface water for drinking	*By amount, type, source*
			Surface water used as a material (non-drinking purposes)	*By amount & source*
			Freshwater surface water used as an energy source	*By amount, type, source*
			Coastal and marine water used as energy source	*By amount, type, source*
		Ground water for used for nutrition, materials or energy	Ground (and subsurface) water for drinking	*By amount, type, source*
			Ground water (and subsurface) used as a material (non-drinking purposes)	*By amount & source*
			Ground water (and subsurface) used as an energy source	*By amount & source*
		Other aqueous ecosystem outputs	Other	
			Mineral substances used for nutritional	*Amount by type*

[242] CICES version 5.1 spreadsheet

	Non-aqueous natural abiotic ecosystem outputs	Mineral substances used for nutrition, materials or energy	Mineral substances used for material purposes	*Amount by type*	ABIOTIC EXTENSION
			Mineral substances used for as an energy source	*Amount by type*	
		Non-mineral substances or ecosystem properties used for nutrition, materials or energy	Non-mineral substances or ecosystem properties used for nutritional purposes	*Amount by type*	
			Non-mineral substances used for materials	*Amount by type*	
			Wind energy	*Amount by type*	
			Solar energy	*Amount by type*	
			Geothermal	*Amount by type*	
		Other mineral or non-mineral substances or ecosystem properties used for nutrition, materials or energy	Other		
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Bio-remediation by micro-organisms, algae, plants, and animals	*By type of living system or by waste or subsistence type*	
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	*By type of living system, or by water or substance type*	
		Mediation of nuisances of anthropogenic origin	Smell reduction	By type of living system	
			Noise attenuation	By type of living system	
			Visual screening	By type of living system	
	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Control of erosion rates	*By reduction in risk, area*	
			Buffering and attenuation of mass movement	*By reduction in risk, area protected*	
			Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	*By depth/volumes*	
			Wind protection	*By reduction in risk, area protected*	
			Fire protection	*By reduction in risk, area protected*	
		Lifecycle maintenance, habitat and gene pool protection	Pollination (or 'gamete' dispersal in a marine context)	*By amount and pollinator*	
			Seed dispersal	*By amount and dispersal agent*	
			Maintaining nursery populations and habitats (Including gene pool protection)	*By amount and source*	
		Pest and disease control	Pest control (including invasive species)	*By reduction in incidence, risk, area protected by type of living system*	
			Disease control	*By reduction in incidence, risk, area protected by type of living system*	
		Regulation of soil quality	Weathering processes and their effect on soil quality	*By amount/concentration and source*	
			Decomposition and fixing processes and their effect on soil quality	*By amount/concentration and source*	
		Water conditions	Regulation of the chemical condition of freshwaters by living processes	*By type of living system*	
			Regulation of the chemical condition of salt waters by living processes	*By type of living system*	
		Atmospheric composition and conditions	Regulation of chemical composition of atmosphere and oceans	*By contribution of type of living system to amount, concentration or climatic parameter*	
			Regulation of temperature and humidity, including ventilation and transpiration	*By contribution of type of living system to amount, concentration or climatic parameter*	
	Other types of regulation and maintenance service by living processes	Other	Other		
Regulation & Maintenance (Abiotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of waste, toxics and other nuisances by non-living processes	Dilution by freshwater and marine ecosystems	*Amount by type*	ABIOTIC EXTENSION
			Dilution by atmosphere	*Amount by type*	
			Mediation by other chemical or physical means (e.g. via Filtration, sequestration, storage or accumulation)	*Amount by type*	
		Mediation of nuisances of anthropogenic origin	Mediation of nuisances by abiotic structures or processes	*Amount by type*	
	Regulation of physical, chemical, biological conditions	Regulation of baseline flows and extreme events	Mass flows	*Amount by type*	
			Liquid flows	*Amount by type*	
			Gaseous flows	*Amount by type*	
		Maintenance of physical, chemical, abiotic conditions	Maintenance and regulation by inorganic natural chemical and physical processes	*Amount by type*	

	Other type of regulation and maintenance service by abiotic processes	Other	Other	
Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Physical and experiential interactions with natural environment	Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions	*By type of living system or environmental setting*
		Physical and experiential interactions with natural environment	Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions	*By type of living system or environmental setting*
		Intellectual and representative interactions with natural environment	Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge	*By type of living system or environmental setting*
		Intellectual and representative interactions with natural environment	Characteristics of living systems that enable education and training	*By type of living system or environmental setting*
			Characteristics of living systems that are resonant in terms of culture or heritage	*By type of living system or environmental setting*
			Characteristics of living systems that enable aesthetic experiences	*By type of living system or environmental setting*
	Indirect, remote, often indoor interactions with living systems that do not require presence in the environmental setting	Spiritual, symbolic and other interactions with natural environment	Elements of living systems that have symbolic meaning	*By type of living system or environmental setting*
			Elements of living systems that have sacred or religious meaning	*By type of living system or environmental setting*
			Elements of living systems used for entertainment or representation	*By type of living system or environmental setting*
		Other biotic characteristics that have a non-use value	Characteristics or features of living systems that have an existence value	*By type of living system or environmental setting*
		Other biotic characteristics that have a non-use value	Characteristics or features of living systems that have an option or bequest value	*By type of living system or environmental setting*
	Other characteristics of living systems that have cultural	Other	Other	
Cultural (Abiotic)	Direct, in-situ and outdoor interactions with natural physical systems that depend on presence in the environmental setting	Physical and experiential interactions with natural abiotic components of the environment	Natural, abiotic characteristics of nature that enable active or passive physical and experiential interactions	*Amount by type*
		Intellectual and representative interactions with abiotic components of the natural environment	Natural, abiotic characteristics of nature that enable intellectual interactions	*Amount by type*
	Indirect, remote, often indoor interactions with physical systems that do not require presence in the environmental setting	interactions with the abiotic components of the natural environment	Natural, abiotic characteristics of nature that enable spiritual, symbolic and other interactions	*Amount by type*
		Other abiotic characteristics that have a non-use value	Natural, abiotic characteristics or features of nature that have either an existence, option or bequest value	*Amount by type*
	Other abiotic characteristics of nature that have cultural significance	Other	Other	

ABIOTIC EXTENSION

IPBES classification of Nature's Contributions to People (NCPs)[243]

	Reporting categories of nature's contributions to people	Brief explanation and some examples	Type of contribution
1	Habitat creation and maintenance	The formation and continued production, by ecosystems or organisms within them, of ecological conditions necessary or favourable for organisms important to humans to live in. E.g. nesting, feeding, and mating sites for birds and mammals, resting and overwintering areas for migratory mammals, birds and butterflies, nurseries for juvenile stages of fish and refuge for fish and invertebrates	Regulating service
2	Pollination and dispersal of seeds and other propagules	Facilitation by animals of movement of pollen among flowers, and dispersal of seeds, larvae or spores of organisms important to humans	Regulating service
3	Regulation of air quality	Regulation (by impediment or facilitation) by ecosystems, of CO_2/O_2 balance, O_3 for UV-B absorption, levels of sulphur oxide, nitrogen oxides (NOx), volatile organic compounds (VOC), particulates, aerosols . Filtration, fixation, degradation or storage of pollutants that directly affect human health or infrastructure	Regulating service
4	Regulation of climate	Climate regulation by ecosystems (including regulation of global warming) through: . Positive or negative effects on emissions of greenhouse gases (e.g. biological carbon storage and sequestration; methane emissions from wetlands) . Positive or negative effects on biophysical feedbacks from vegetation cover to atmosphere, such as those involving albedo, surface roughness, long-wave radiation, evapotranspiration (including moisture-recycling) . Direct and indirect processes involving biogenic volatile organic compounds . Regulation of aerosols and aerosol precursors	Regulating service
5	Regulation of ocean acidification	Regulating, by photosynthetic organisms (on land or in water), of atmospheric CO_2 concentrations and so seawater pH, which affects associated calcification processes by many marine organisms important to humans (such as corals)	Regulating service
6	Regulation of freshwater quantity, flow and timing*	Regulation, by ecosystems, of the quantity, location and timing of the flow of surface and groundwater used for drinking, irrigation, transport, hydropower, and as the support of non-material contributions (NCP 15, 16, 17) Regulation of flow to water-dependent natural habitats that in turn positively or negatively affect people downstream, including via flooding (wetlands including ponds, rivers, lakes, swamps) Modifying groundwater levels, which can ameliorate dryland salinization in unirrigated landscapes	Regulating service
7	Regulation of freshwater and coastal water quality	Regulation – through filtration of particles, pathogens, excess nutrients, and other chemicals – by ecosystems or particular organisms, of the quality of water used directly (e.g. drinking) or indirectly (e.g. aquatic foods, irrigated food and fibre crops, freshwater and coastal habitats of heritage value)	Regulating service
8	Formation, protection and decontamination of soils and sediments	Sediment retention and erosion control, soil formation and maintenance of soil structure and processes (e.g. such as decomposition and nutrient cycling) that underlie the continued fertility of soils important to humans. Filtration, fixation, degradation or storage of chemical and biological pollutants (pathogens, toxics, excess nutrients) in soils and sediments that are important to humans	Regulating service

[243] IPBES. (February 2017). Update on the classification of nature's contributions to people by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

9	Regulation of hazards and extreme events	Amelioration, by ecosystems, of the impacts on humans or their infrastructure caused by e.g. floods, wind, storms, hurricanes, seawater intrusion, tidal waves, heat waves, tsunamis, high noise levels Reduction, by ecosystems of hazards like landslides, avalanches	Regulating service
10	Regulation of organisms detrimental to humans	. Regulation, by ecosystems or organisms, of pests, pathogens, predators, competitors, etc. that affect humans, plants and animals, including e.g.: . Regulation by predators or parasites of the population size of non-harmful important animals (e.g. large herbivore populations by wolves or lions) . Regulation (by impediment or facilitation) of the abundance or distribution of potentially harmful organisms (e.g. venomous, toxic, allergenic, predators, parasites, competitors, disease vectors and reservoirs) over the landscape or seascape . Removal of animal carcasses and human corpses by scavengers (e.g. vultures in Zoroastrian and some Tibetan Buddhist traditions) . Regulation (by impediment or facilitation) of biological impairment and degradation of infrastructure (e.g. damage by pigeons, bats, termites, strangling figs to buildings)	Regulating service
11	Energy	Production of biomass-based fuels, such as biofuel crops, animal waste, fuelwood, agricultural residue pellets	Material
12	Food and feed	Production of food from wild, managed, or domesticated organisms, such as fish, beef, poultry, game, dairy products, edible crops, mushrooms, bushmeat and edible invertebrates, honey, edible wild fruits and tubers Production of feed for domesticated animals (e.g. livestock, work and support animals, pets) or for aquaculture, from the same sources	Material
13	Materials and assistance	. Production of materials derived from organisms in crops or wild ecosystems, for construction, clothing, printing, ornamental purposes (e.g. wood, fibres, waxes, paper, resins, dyes, pearls, shells, coral branches). . Direct use of living organisms for decoration (i.e. ornamental plants in parks and households, ornamental fish), company (i.e. pets), transport, and labor (including herding, searching, guidance, guarding)	Material
14	Medicinal, biochemical and genetic resources	. Production of materials derived from organisms (plants, animals, fungi, microbes) used for medicinal and veterinary purposes . Production of genes and genetic information used for plant and animal breeding and biotechnology	Material
15	Learning and inspiration	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for the development of the capabilities that allow humans to prosper through education, acquisition of knowledge and development of skills for well-being, scientific information, and inspiration for art and technological design (e.g. biomimicry)	Non-material
16	Physical and psychological experiences	Provision, by landscapes, seascapes, habitats or organisms, of opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, tourism and aesthetic enjoyment based on the close contact with nature. E.g. hiking, recreational hunting and fishing, birdwatching, snorkeling, gardening	Non-material

17	Supporting identities	Landscapes, seascapes, habitats or organisms being the basis for religious, spiritual, and social-cohesion experiences Provisioning of opportunities by nature for people to develop a sense of place, purpose, belonging, rootedness or connectedness, associated with different entities of the living world (e. g. cultural and heritage landscapes, sounds, scents and sights associated with childhood experiences, iconic animals, trees or flowers) Basis for narratives and myths, rituals and celebrations provided by landscapes, seascapes, habitats, species or organisms (e.g. sacred groves, sacred trees, totem animals) Source of satisfaction derived from knowing that a particular landscapes, seascape, habitat or species exist in the present	Non-material
18	Maintenance of options	Capacity of ecosystems, habitats, species or genotypes to keep human options open in order to support a later good quality of life. Examples include: . Benefits (including those of future generations) associated with the continued existence of a wide variety of species, populations and genotypes . Future benefits (or threats) derived from keeping options open for yet unknown discoveries and unanticipated uses of particular organisms or ecosystems that already exist (e.g. new medicines or materials) . Future benefits (or threats) that may be anticipated from on-going biological evolution (e.g. adaptation to a warmer climate, to emergent diseases, development of resistance to antibiotics and other control agents by pathogens and weeds)	Non-material

8. *Hydrological NCP are fundamentally conceived as regulating NCP, because the primary impact of ecosystems on water is the modification of its flows, not the creation or breakdown of water molecules.

SEEA EA classification of ecosystem services (version 5, 2021)[244]

Categories	Ecosystem Services		Description
PROVISIONING SERVICES	**Biomass provisioning services**	**Crop provisioning services** (final service)	Growth of cultivated plants that are harvested by economic units for various uses including food and fiber production, fodder and energy.
		Grazed biomass provisioning services (final or intermediate service)	Growth of grazed biomass that is an input to the growth of cultivated livestock.
		Livestock provisioning services (final service)	Growth of cultivated livestock and livestock products (e.g., meat, milk, eggs, wool, leather), that are used by economic units for various uses, primarily food production.
		Aquaculture provisioning services (final service)	Growth of animals and plants (e.g. fish, shellfish, seaweed) in aquaculture facilities that are harvested by economic units for various uses.
		Wood provisioning services (final service)	Growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy.
		Wild fish and other natural aquatic products provisioning services (final service)	Growth of fish and other aquatic biomass that are captured in uncultivated production contexts by economic units for various uses, primarily food production.

[244] UN Department of Economic and Social Affairs Statistical Division, SEEA. (February 2021). System of Environmental-Economic Accounting—Ecosystem Accounting. Final Draft. Version 5.

		Wild animals, plants and other biomass provisioning services (final service)	Growth of wild animals, plants and other biomass that are captured and harvested in uncultivated production contexts by economic units for various uses.
	Genetic material services (intermediate service to biomass provisioning)		Contributions from all biota (including seed, spore or gamete production) that are used by economic units, e.g. (i) to develop new animal and plant breeds; (ii) in gene synthesis; or (iii) in product development directly using genetic material.
	Water supply (final service)		Water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including household consumption
REGULATING AND MAINTENANCE SERVICES	**Global climate regulation services** (final ecosystem service)		Regulation of the chemical composition of the atmosphere and oceans that affect global climate through the **accumulation and retention of carbon and other GHG** (e.g., methane) in ecosystems and the ability of ecosystems to remove carbon from the atmosphere.
	Rainfall pattern regulation services (at sub-continental scale) (final or intermediate service)		Ecosystem contributions of vegetation, in particular forests, in maintaining rainfall patterns through evapotranspiration at the sub-continental scale. Forests and other vegetation recycle moisture back to the atmosphere where it is available for the generation of rainfall. Rainfall in interior parts of continents fully depends upon this recycling.
	Local (micro and meso) climate regulation services (final or intermediate service)		Regulation of ambient atmospheric conditions (including micro and mesoscale climates) through the presence of vegetation that improves the living conditions for people and supports economic production. Examples include the evaporative cooling provided by urban trees ('green space'), the role of urban water bodies ('blue space') and the contribution of trees in providing shade for humans and livestock.
	Air filtration services (final service)		Filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, that mitigate the harmful effects of the pollutants.
	Soil quality regulation services (intermediate service)		Decomposition of organic and inorganic materials and to the fertility and characteristics of soils, e.g., for input to biomass production.
	Soil and sediment retention services	**Soil erosion control services** (final or intermediate service)	Stabilizing effects of vegetation that reduce the loss of soil (and sediment) and support e.g., agricultural activity, water supply).
		Landslide mitigation (final service)	Stabilizing effects of vegetation that mitigates or prevents potential damage to human health and safety and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil and rock.
	Solid waste remediation (final or intermediate service)		Transformation of organic or inorganic substances, through the action of micro-organisms, algae, plants and animals that mitigates their harmful effects.
	Water purification services (water quality amelioration) (final or intermediate service)	**Retention and breakdown of nutrients**	Restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health.
		Retention and breakdown of other pollutants	
	Water flow regulation services	**Baseline flow maintenance services** (final or intermediate service)	Regulation of river flows and groundwater and lake water tables, derived from the ability of ecosystems to absorb and store water, and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water.
		Peak flow	Regulation of river flows and groundwater and lake water tables,

		mitigation services (final service)	derived from the ability of ecosystems to absorb and store water, and hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection.
	Flood mitigation services	**Coastal protection services** (final service)	Contributions of linear elements in the seascape, for instance coral reefs, sand banks, dunes or mangrove ecosystems along the shore, in protecting the shore and thus mitigating the impacts of tidal surges or storms on local communities.
		River flood mitigation services (final service)	Contributions of riparian vegetation which provides structure and a physical barrier to high water levels and thus mitigates the impacts of floods on local communities. River flood mitigation services will be supplied together with peak flow mitigation services in providing the benefit of flood protection.
	Storm mitigation services (final service)		Contributions of vegetation including linear elements, in mitigating the impacts of wind, sand and other storms (other than water related events) on local communities.
	Noise attenuation services (final service)		Reduction in the impact of noise on people that mitigates its harmful or stressful effects.
	Pollination services (final or intermediate service)		Fertilization of crops by wild pollinators that maintains or increases the abundance and/or diversity of other species.
	Biological control services	**Pest control services** (final or intermediate service)	Reduction in the incidence of species that may prevent or reduce the effects of pests on biomass production processes or other economic and human activity.
		Disease control services (final service)	Reduction in the incidence of species that may prevent or reduce the effects of species on human health.
	Nursery population and habitat maintenance services (final or intermediate service)		Contributions necessary for sustaining populations of species either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service may input to a number of different final ecosystem services incl. biomass provision.
CULTURAL SERVICES	**Recreation-related services** (final service)		contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, in-situ, physical and experiential interactions with the environment. This includes services to both locals and non-locals (i.e. visitors, including tourists). Recreation-related services may also be supplied to those undertaking recreational fishing and hunting. This is a final ecosystem service.
	Visual amenity services (final service)		Contributions to local living conditions, in particular through the biophysical characteristics and qualities of ecosystems that provide sensory benefits, especially visual. This service combines with other ecosystem services, including recreation-related services and noise attenuation services to underpin amenity values. This is a final ecosystem service.
	Education, scientific and research services (final service)		Contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use the environment through intellectual interactions with the environment. This is a final ecosystem service.
	Spiritual, artistic and symbolic services (final service)		Contributions, in particular through the biophysical characteristics and qualities of ecosystems, that are recognized by people for their cultural, historical, aesthetic, sacred or religious significance. These services may underpin people's cultural identity and may inspire people to express themselves through various artistic media. This is a final ecosystem service.
	Other		

Flows related to non-use values	**Ecosystem and species appreciation**	Wellbeing that people derive from the existence and preservation of the environment for current and future generations, irrespective of any direct or indirect use.

APPENDIX E

Definitions of Climate change performance criteria

CLIMATE TRANSITION RISKS (mitigation)	
Scope 1 emissions	All direct GHG[245] emissions, - including fugitive emissions, stationary fuel combustion, operation fleet emissions, waste emissions, wastewater emissions, biomass emissions, industrial process emissions[246]-, that occur from sources that the asset owns or controls. Occur during operations but also during construction or maintenance works and during decommissioning of a project (the direct emissions of the construction worksite)
Scope 2 emissions	Indirect GHG emissions from the off-site generation of purchased energy (electricity, steam, or heating/cooling) for own consumption by the facilities or equipment that the asset company owns or controls
Scope 3 emissions	(Or embodied carbon) GHG emissions from the activities of the asset from sources not owned or controlled by the asset, that occur in the value chain of the reporting company, including both upstream and downstream emissions. Scope 3 emissions could include: the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g., transmission and distribution losses), outsourced activities, and waste disposal. (source: TCFD)
Scope 3 emissions (user)	Downstream emissions by the end-user. Most relevant to transportation projects: Avoided or increased emissions by private vehicles due to avoided access closures (e.g. during construction); avoided congestion (due to adequate system capacity); state of good repair; provision of mass-transit transport options etc. The importance of this type of emissions is more obvious in transportation projects (such as projects that increase capacity, transit or road improvements, or projects that propose a mode shift from higher emitting modes to e.g. high-speed rail). In such cases the contribution of the project is the avoided emissions by the end-user. These emissions are not direct and are not captured by the Envision credit CR1.2 Reduce Greenhouse emissions.
Energy efficiency	Reduction in energy consumption In energy generation projects the measure of **energy efficiency** is energy

[245] Greenhouse gases: In line with Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) and amendment issued by the Greenhouse Gas Protocol on May 2013 the basket of greenhouse gases (GHGs) consists of:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbon family of gases (HFCs);
- Perfluorocarbon family of gases (PFCs);
- Sulfur hexafluoride (SF_6), and;
- Nitrogen trifluoride (NF_3).

[246] Referenced in Envision credit CR1.2.

		conversion efficiency with the goal of increasing the capture of electrical, mechanical, or thermal energy output of the system. Similarly, energy distribution projects the measure of energy efficiency is reductions in energy loss in energy delivery. (source: Envision manual V3, credit RA 2.1)
Decarbonization		Decarbonization of electricity or fuels through: - on-site renewable energy generation, - purchase of renewable fuels - purchase from the grid through a direct purchase agreement (e.g. renewable energy purchase agreement) RECs (Renewable Energy Credits)
Electrification		The process of replacing use of fossil fuels with electricity as a source of energy (e.g. electrification of fleet)
Carbon capture & storage		Measures to remove carbon from the atmosphere and permanently store it through any natural or mechanical methods of carbon sequestration, as well as purchased carbon offsets
CLIMATE PHYSICAL RISKS (adaptation)		
Service continuity risk		Interruptions in service
Physical asset risk		Damage to assets in 'high risk locations exposed to climate change-driven physical risks. Physical risks emanating from climate change can be event-driven (acute) such as increased severity of extreme weather events (e.g., cyclones, droughts, floods, and fires). They can also relate to longer-term shifts (chronic) in precipitation and temperature and increased variability in weather patterns (e.g., sea level rise).
Resource availability	**water**	Long-term future dependencies on water
	materials	Long-term future dependencies on materials for maintenance (e.g. minor or major rehabilitations)
	land	Long-term dependencies on land e.g. for expansion
	workforce	Impacts on the workforce (health and safety, absenteeism); employee satisfaction, employee attraction and retention (related to reputation) that impact project service
Supply chain continuity risk		Avoided supply chain interruption/ long-term reliability of supply chain and ability to operate under various conditions due to resource substitutes/ diversification;
CLIMATE PHYSICAL OPPORTUNITIES		
Resource efficiency (water, materials, soil)		The ability to deliver greater value with less input, reducing pressure on limited natural resources. It counts alternative practices that treat the byproducts of processes as a valuable resource (reuse of resources)
Durability (materials, structures)		The ability to withstand an extreme event, but also the ability to resist long-term wear and decay associated with project operations, therefore implying a longer useful life, reducing the need for maintenance and replacement. Material degradation is accentuated by exposure to chronic stressors, such extreme heat or precipitation or flooding, a result of climate change.
Adaptability		The ability of increased operational tolerance for adaptation to long-term changes, enabling reliability, as well as increased physical flexibility, easy reconfiguration and refurbishment. This ability increases the possibilities for repurposing to alternative future uses, and as a result allows the system to extend its useful life. Increased operational tolerance requires expansion of the range of conditions in which a system can function, grow or be configured.
Redundancy		Redundancy, or diversity, refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfill a particular function, therefore 'spreading risk' from a single

	reliance point to multiple. Redundancy is intentional and not the result of inefficient design, such as oversizing of structures or systems. Redundancy in the case of transportation projects is also provision of multiple transport mode options as alternatives to private vehicle use, increased system capacity to reduce congestion, as well as system capacity to address projected growth in demand.
Integration	Integration is a quality within and between systems and across different scales of operation that improves overall resilience and system performance. Integration reduces the risk of systemic and cascading failures, while promoting efficiency by leveraging co-benefits, thus avoiding duplication of components and/or system diversity without the need for redundant backups. Integration is the subject of credit CR2.6 Improve Infrastructure Integration. The credit assesses 'the degree to which the project is functionally integrated into connected systems, where beneficial and appropriate, in order to increase resilience and systems performance'. The first level is integration of internal systems within the project, the next level is integration with external infrastructure systems and optimal performance is integration at the community level. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops.
Reflective capacity	Reflective systems are accepting of the inherent uncertainty and change in today's conditions, particularly relevant for the long-lived infrastructure projects. They have mechanisms in place to continuously evolve, plan-do-check-act systems, revisiting plans and modifying standards or norms based on emerging evidence, rather than seeking permanent solutions. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making, as well as can capture new opportunities as they arise. (e.g. long-term monitoring with reporting or preparedness systems in order to learn and improve performance over time)
Inclusivity	The ability of establishing shared action and responsibilities, as well as knowledge sharing. It is particularly critical in order to deal with multidisciplinary issues like climate change, disaster risk reduction or emergency response through coordination. Often individuals from diverse backgrounds, skill sets can add value by bringing attention to threats and vulnerabilities that might "Inclusivity emphasizes the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience.

Definitions of Biodiversity performance criteria

No net biodiversity loss	avoid		Measures taken to avoid creating impacts from the outset
	minimize		Measures taken to reduce the duration, intensity or extent of impacts that cannot be avoided
	restore		Measures taken to rehabilitate degraded ecosystems
	offset	Off-site and/or onsite (with like-for-like)	Measures taken to compensate for any residual adverse impacts off-site (restore and protect habitat off-site), after full implementation of the previous three steps. Using a biodiversity offset is a last resort for any developer and is only

			considered after all steps of the Mitigation Hierarchy
Biodiversity net gain		On-site (with better) or on adjacent parcel	Off-site offsets aim to achieve at least no net loss but **preferably a net gain to biodiversity.**
	renew		Proactively create ecosystems; creation of new habitats, expansion of conservation and enhancement in existing ecosystems; provision of new resources
Pressures on biodiversity	Land, freshwater, sea change		Land, freshwater and sea change (area) causes habitat and ecosystem loss, degradation and fragmentation and can lead to the extinction of species and loss of ecosystem functions and related ecosystem services. Land-use change is the leading driver of terrestrial and freshwater biodiversity loss.
	Resource exploitation		Exploitation of animals, plants and other organisms, as well as natural resources such as timber and water. The rate of resources exploitation often exceeds their capacity for regeneration with ecological consequences including extinction of species, genetic drift (a change in the gene pool of a population) and habitat degradation.
	Pollution	Water	Pollution including fertilizers and pesticides, industrial emissions and marine plastic pollution, cause environmental change, such as modifying the physical and chemical state of soil, air and water, resulting in the degradation of ecosystem quality and threats to plant and animal species. Light and noise pollution, which can result from business operations, also impacts biodiversity by modifying species behavior and distribution.
		Air	
		Soil	
		Waste	
		Noise	
		light	
	Climate change		e.g. changes in temperature, precipitations, and sea level rise have direct and indirect effects on the distribution of species, their physiology and behavior and on modification of habitats.
	Introduction of invasive species		Invasive species(or alien species), which may be introduced deliberately or accidentally, pose a threat to ecosystems, habitats and native species through their establishment and propagation
Change in the state of biodiversity	Species		changes relative to a defined baseline/reference state, to the condition and status of species including: • changes in species population and abundance; • risk of species extinction; • areas of critical habitat for species in priority geographical areas • Number of IUCN Red List species and national conservation list species within priority geographical areas • Threatened and endangered species fatalities
	Ecosystems		changes relative to a defined baseline/reference state including: • Number or percentage of sites in which ecological richness is progressing /stable/ regressing • Ecosystem/habitat cover change, e.g. forest

		area as a percentage of total land area or tree cover loss(ha) • Ecosystem extent/ connectivity and integrity • Terrestrial acreage disturbed, percentage of impacted area restored • Soil C (tons C/ha) • Net habitat gain

Description of ecosystem services (climate change- & infrastructure-relevant (UN SEEA-EA)

Ecosystem services (climate change-relevant)	Global climate regulation (including carbon sequestration and storage)		Regulation of the chemical composition of the atmosphere and oceans that affect global climate through the **accumulation and retention of carbon and other GHG** (e.g., methane) in ecosystems and the ability of ecosystems to remove carbon from the atmosphere.
	Rainfall pattern regulation (at sub-continental scale)		Ecosystem contributions of vegetation, in particular forests, in maintaining rainfall patterns through evapotranspiration at the sub-continental scale. Forests and other vegetation recycle moisture back to the atmosphere where it is available for the generation of rainfall. Rainfall in interior parts of continents fully depends upon this recycling.
	Local (micro and meso) climate regulation		Regulation of ambient atmospheric conditions (including micro and mesoscale climates) through the presence of vegetation that improves the living conditions for people and supports economic production. Examples include the evaporative cooling provided by urban trees ('green space'), the role of urban water bodies ('blue space') and the contribution of trees in providing shade for humans and livestock.
	Air filtration		Filtering of air-borne pollutants through the deposition, uptake, fixing and storage of pollutants by ecosystem components, particularly plants, that mitigate the harmful effects of the pollutants.
	Soil quality regulation		Decomposition of organic and inorganic materials and to the fertility and characteristics of soils, e.g., for input to biomass production.
	Soil and sediment retention	Soil erosion control	Stabilizing effects of vegetation that reduce the loss of soil (and sediment) and support e.g., agricultural activity, water supply).
		Landslide mitigation	Stabilizing effects of vegetation that mitigates or prevents potential damage to human health and safety and damaging effects to buildings and infrastructure that arise from the mass movement (wasting) of soil and rock.
	Solid waste remediation		Transformation of organic or inorganic substances, through the action of micro-organisms, algae, plants and animals that mitigates their harmful effects
	Water purification (water quality amelioration)	Retention and breakdown of nutrients	Restoration and maintenance of the chemical condition of surface water and groundwater bodies through the breakdown or removal of nutrients and other pollutants by ecosystem components that mitigate the harmful effects of the pollutants on human use or health.
		Retention and breakdown of other pollutants	

	Water flow regulation	Baseline flow maintenance	Regulation of river flows and groundwater and lake water tables, derived from the ability of ecosystems to absorb and store water, and gradually release water during dry seasons or periods through evapotranspiration and hence secure a regular flow of water.
		Peak flow mitigation	Regulation of river flows and groundwater and lake water tables, derived from the ability of ecosystems to absorb and store water, and hence mitigate the effects of flood and other extreme water-related events. Peak flow mitigation services will be supplied together with river flood mitigation services in providing the benefit of flood protection.
	Flood mitigation	Coastal protection	Contributions of linear elements in the seascape, for instance coral reefs, sand banks, dunes or mangrove ecosystems along the shore, in protecting the shore and thus mitigating the impacts of tidal surges or storms on local communities.
		River flood mitigation	Contributions of riparian vegetation which provides structure and a physical barrier to high water levels and thus mitigates the impacts of floods on local communities. River flood mitigation services will be supplied together with peak flow mitigation services in providing the benefit of flood protection.
	Storm mitigation		Contributions of vegetation including linear elements, in mitigating the impacts of wind, sand and other storms (other than water related events) on local communities.
	Noise attenuation		Reduction in the impact of noise on people that mitigates its harmful or stressful effects.
	Pollination		Fertilization of crops by wild pollinators that maintains or increases the abundance and/or diversity of other species.
	Biological control	Pest control	Reduction in the incidence of species that may prevent or reduce the effects of pests on biomass production processes or other economic and human activity.
	Nursery population and habitat maintenance		Contributions necessary for sustaining populations of species either through the maintenance of habitats (e.g., for nurseries or migration) or the protection of natural gene pools. This service may input to a number of different final ecosystem services incl. biomass provision.
	Biomass provisioning	Crop provisioning (energy crops)	Growth of cultivated plants that are harvested by economic units for various uses **including energy.**
		Wood provisioning	Growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy.
		Wild plants (terrestrial and aquatic e.g. algae) used as a source of energy	
		Livestock provisioning	

		(livestock manure as fertilizer)	
		Sand, rock, gravel etc.	
	Water supply	Potable water	Water flow regulation, water purification, and other ecosystem services to the supply of water of appropriate quality to users for various uses including: potable water, non-potable water as material input to processes, irrigation, and freshwater surface water and coastal and marine water as energy source
		Non-potable water for use as material to processes, irrigation	
		freshwater surface water and coastal and marine water as energy source	

APPENDIX F

Identified high-priority criteria for biodiversity performance (detailing dependencies on biodiversity)				Overlap with CC criterion
Pressures on biodiversity	**Land, freshwater, sea change**			
	Resource exploitation			**Resource availability risk**
	Pollution	Water		
		Air		
		Soil		
		Waste		
		Noise		
		Light		
	Climate change			**all**
	Introduction of invasive species			
	~~**Natural systems modification**~~			
Change in the state of biodiversity	**Species**			
	Ecosystems			
	Ecosystem services (climate change-relevant) available to the project and/or community	Global climate regulation (including carbon sequestration & storage)		**Carbon capture & storage**
		Rainfall pattern regulation (at sub-continental scale)		**Resource availability risk** (water)
		Local (micro and meso) climate regulation		**Energy efficiency**
		Air filtration		
		Soil quality regulation		
		Soil and sediment retention	Soil erosion control	
			Landslide mitigation	**Physical asset risk**
		Solid waste remediation		
		Water purification (water quality amelioration)	Retention and breakdown of nutrients	
			Retention and breakdown of other pollutants	
		Water flow regulation	Baseline flow maintenance	
			Peak flow mitigation	**Physical asset**

		Flood mitigation	Coastal protection	**risk**
			River flood mitigation	
		Storm mitigation		
		Noise attenuation		
		Pollination		
		Biological control	Pest control	
			Disease control	
		Nursery population and habitat maintenance		
		Biomass provisioning	Crop provisioning (energy crops)	**De-carbonization**
			Wood provisioning	**Resource availability risk** (materials)
			Wild plants provisioning (terrestrial and aquatic e.g. algae) used as a source of energy	**De-carbonization**
			Livestock provisioning (fertilizer (livestock manure)	
		Other provisioning	Sand, rock, gravel etc.	**Resource availability risk** (materials)
		Water supply	Potable water	**Resource availability risk** (water)
			Non-potable water for use as material to processes, irrigation	
			freshwater surface water and coastal and marine water as energy source	
Biodiversity management responses	**No net biodiversity loss**	avoid		
		minimize		
		restore		
		offset	Off-site	
			On-site	
	Net biodiversity gain	renew		Overlaps with resource efficiency

APPENDIX G

REQUEST FOR INFORMATION TO ENVISION VERIFIED PROJECT TEAMS

Request for information for the [-----] project (assessed with Envision V3)

The present request forms part of an ongoing effort to apply and test the Zofnass Research outcomes in real-world projects that demonstrate exceptional performance in terms of climate change mitigation and/ or adaptation. The [-----] project was identified as an exemplary project in this sense.

It is requested that the project team provides if possible the information submitted as part of the Envision score cards (Credit Documentation Cover Sheets) for the following selected credits identified as high-priority credits for assessment of climate change action:

Category	Subcategory	Credit
CLIMATE & RESILIENCE	Emissions	CR1.1 Reduce Net Embodied Carbon
		CR1.2 Reduce Greenhouse Gas Emissions
	Resilience	CR2.1 Avoid Unsuitable Development
		CR2.2 Assess Climate Change Vulnerability
		CR2.3 Evaluate Risk and Resilience
		CR2.4 Establish Resilience Goals and Strategies
		CR2.5 Maximize Resilience
		CR2.6 Improve Infrastructure Integration
	Innovation	CR0.0 Innovate or Exceed Credit Requirements
RESOURCE ALLOCATION	Materials	RA1.1 Support Sustainable Procurement Practices
		RA1.2 Use Recycled Materials
		RA1.3 Reduce Operational Waste
		RA1.4 Reduce Construction Waste
	Energy	RA2.1 Reduce Operational Energy Consumption
		RA2.2 Reduce Construction Energy Consumption
		RA2.3 Use Renewable Energy
		RA2.4 Commission & Monitor Energy Systems
	Water	RA3.1 Preserve Water Resources
		RA3.2 Reduce Operational Water Consumption
		RA3.3 Reduce Construction Water Consumption
		RA3.4 Monitor Water Systems
	Innovation	RA0.0 Innovate or Exceed Credit Requirements
LEADERSHIP	Collaboration	LD1.4 Pursue Byproduct Synergies
	Planning	LD2.3 Plan for Long-Term Monitoring and Maintenance
		LD2.4 Plan for end-of-life
	Economy	LD3.3 Conduct a Life-Cycle Economic Evaluation
	Innovation	LD0.0 Innovate or Exceed Credit Requirements
NATURAL WORLD	Conservation	NW2.2 Manage Stormwater
	Ecology	NW3.3 Maintain Floodplain Functions
QUALITY OF LIFE	Purpose	QL1.6 Minimize Construction Impacts
	Wellbeing	QL2.1 Improve Community Mobility
		QL2.2 Encourage Sustainable Transportation
		QL 2.3 Improve Access & Wayfinding

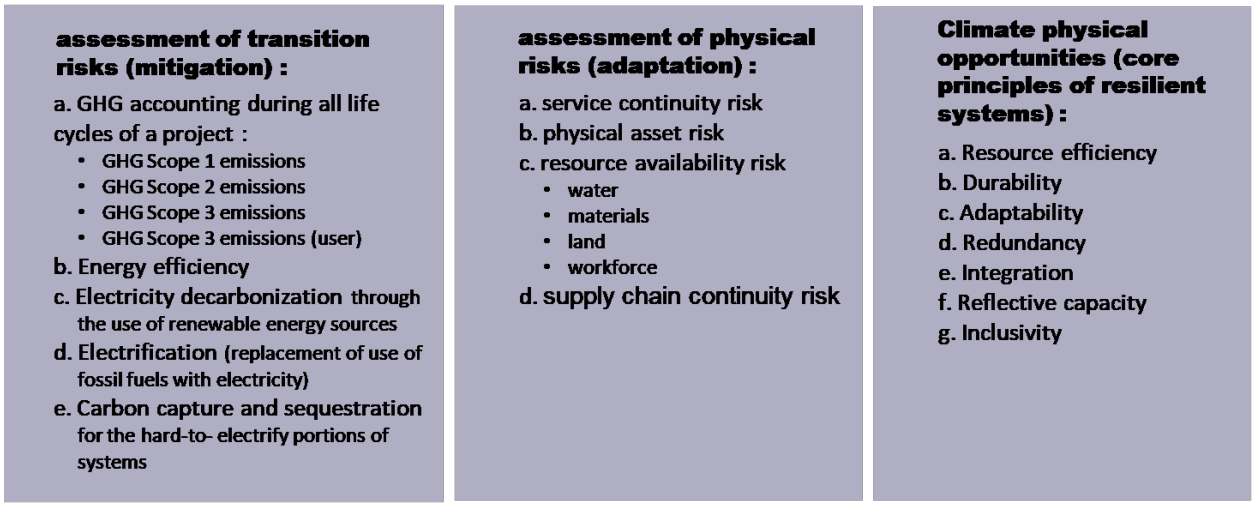
Note: The QL credits are requested only in the case of a transportation project

Brief Overview of 2020-21 Zofnass Research on climate change outcomes

The 2020-21 Zofnass Program research on climate change, under the title: “Assessment of Projects for a. mitigation and adaptation to climate change and b. attractiveness to investments”, aims to assist Envision in the identification of priority projects for climate action. As part of the research findings 30 credits out of the Envision’s 64 credits were identified as ‘high-priority’ credits for assessment of climate

change-related performance, because of their high relevance to climate change mitigation, adaptation or both. [247]

The selected Envision credits are the outcome of a targeted review of the Envision framework based on key criteria identified as critical for projects that contribute to climate change mitigation and adaptation, as shown in the table below:



Continuation of Zofnass Research for the period October 2021- June 2022

The Zofnass research on climate change is currently continued under the updated working tile: 'Assessment of Projects for (a) integrated climate-biodiversity action and (b) attractiveness to investments'.
The need to capture the risk of climate change on biodiversity and biodiversity's role in climate action were identified as additional research areas. Moreover, climate change mitigation and adaptation actions can unintentionally impact biodiversity in the long term. Therefore, the proposed work continues in climate change-related risks and opportunities, expanding the boundary of research to encompass biodiversity & climate change-related risks and opportunities.

The work is motivated by emerging evidence of a biodiversity crisis in parallel with the climate crisis and the related ongoing discourse on the climate-biodiversity nexus and the need for integrated solutions to deal with both threats simultaneously.

Envision as a sustainability assessment tool can highlight and assess these risks in climate action projects. A prioritization tool for the right projects should enable the identification of win-win projects beyond narrowly focused solutions for rapid outcomes. Finally, it is worth highlighting that the continued work is considered essential in the case of assessing the performance of Nature-based Solutions (NbS).

[247] The list of credits for which information is requested consists of the 30 'priority credits', plus the 3 innovation for C&R, RA and LD that can potentially be relevant to climate change action.

To proceed with such analysis and given that the research has not yet concluded on 'key criteria' or 'high-priority' Envision credits for integrated biodiversity-climate action, it would be really helpful to receive information on the Natural World Category credits (Credit Documentation Cover Sheets), as they relate to management of biodiversity impacts, risks and opportunities:

Category	Subcategory	Credit
NATURAL WORLD	Siting	NW1.1 Preserve Sites of high-ecological value
		NW1.2 Provide Wetland & Surface Water Buffers
		NW1.3 Preserve Prime Farmland
		NW1.4 Preserve Undeveloped Land
	Conservation	NW2.1 Reclaim Brownfields
		NW2.3 Reduce Pesticide & Fertilizer Impacts
		NW2.4 Protect Surface & Groundwater Quality
	Ecology	NW3.1 Enhance Functional Habitats
		NW3.2 Enhance Wetland & Surface Water Functions
		NW3.3 Maintain Floodplain Functions
		NW3.4 Control Invasive Species
		NW3.5 Protect Soil Health
	Innovation	NW0.0 Innovate or Exceed Credit Requirements

Thank you in advance for your time.

Request for material for the [-----] project (assessed with Envision V2)

The present request forms part of an ongoing effort to apply and test the Zofnass Research outcomes in real-world projects that demonstrate exceptional performance in terms of climate change mitigation and/ or adaptation. The [-----] project was identified as an exemplary project in this sense.

It is requested that the project team provides if possible the information submitted as part of the Envision score cards (Credit Documentation Cover Sheets) for the following selected credits identified as high-priority credits for assessment of climate change action:

Category	Subcategory	Credit
CLIMATE & RISK	Emissions	CR1.1 Reduce Greenhouse Gas Emissions
	Resilience	CR2.1 Assess Climate Threat
		CR2.2 Avoid traps and Vulnerabilities
		CR2.3 Prepare for Long-Term Adaptability
		CR2.4 Prepare for Short-Term Hazards
		CR2.5 Manage Heat Islands Effects
	Innovation	CR0.0 Innovate or Exceed Credit Requirements
RESOURCE ALLOCATION	Materials	RA1.1 Reduce Net Embodied Energy
		RA1.2 Support Sustainable Procurement Practices
		RA1.3 Use Recycled Materials
		RA1.4 Use Regional Materials

		RA1.5 Divert Waste From landfills
		RA1.7 Provide for Deconstruction and Recycling
	Energy	RA2.1 Reduce Energy Consumption
		RA2.2 Use Renewable Energy
		RA2.3 Commission & Monitor Energy Systems
	Water	RA3.1 Protect Fresh Water Availability
		RA3.2 Reduce Potable Water Consumption
		RA3.3 Monitor Water Systems
	Innovation	RA0.0 Innovate or Exceed Credit Requirements
LEADERSHIP	Management	LD2.1 Pursue By-Product Synergy Opportunities
		LD2.2 Improve Infrastructure Integration
	Planning	LD3.1 Plan for Long-Term Monitoring and Maintenance
		LD3.3 Extend Useful Life
	Innovation	LD0.0 Innovate or Exceed Credit Requirements
NATURAL WORLD	Siting	NW1.4 Avoid Adverse Geology
		NW1.5 Preserve Floodplain Functions
		NW1.6 Avoid Unsuitable Development on Steep Slopes
	Land & Water	NW2.1 Manage Stormwater
QUALITY OF LIFE	Wellbeing	QL2.4 Improve Community Mobility and Access
		QL2.5 Encourage Alternative Modes of Transportation
		QL2.6 Improve Site Accessibility, Safety and Wayfinding

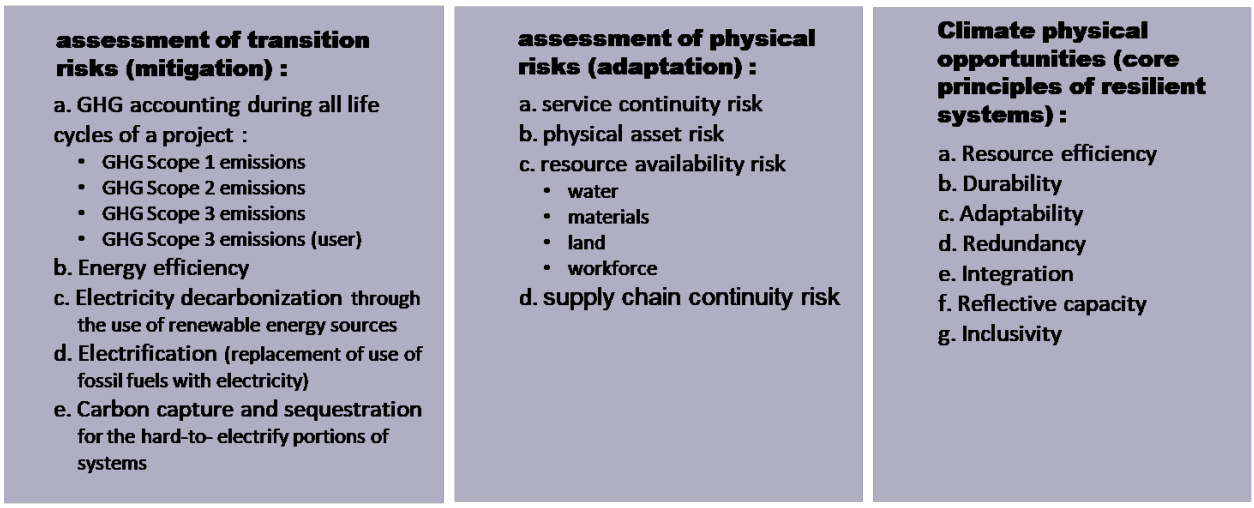
Note: The QL credits are requested only in the case of a transportation project

Brief Overview of 2020-21 Zofnass Research on climate change outcomes

The 2020-21 Zofnass Program research on climate change, under the title: "Assessment of Projects for a. mitigation and adaptation to climate change and b. attractiveness to investments", aims to assist Envision in the identification of priority projects for climate action. As part of the research findings 29 of the Envision's credits were identified as 'high-priority' credits for assessment of climate change-related performance, because of their high relevance to climate change mitigation, adaptation or both.[248]

The selected Envision credits are the outcome of a targeted review of the Envision framework based on key criteria identified as critical for projects that contribute to climate change mitigation and adaptation, as shown in the table below:

[248] The list of credits for which information is requested consists of the 29 'priority credits', plus the 3 innovation for C&R, RA and LD that can potentially be relevant to climate change action.



Continuation of Zofnass Research for the period October 2021- June 2022

The Zofnass research on climate change is currently continued under the updated working tile: 'Assessment of Projects for (a) integrated climate-biodiversity action and (b) attractiveness to investments'.
The need to capture the risk of climate change on biodiversity and biodiversity's role in climate action were identified as additional research areas. Moreover, climate change mitigation and adaptation actions can unintentionally impact biodiversity in the long term. Therefore, the proposed work continues in climate change-related risks and opportunities, expanding the boundary of research to encompass biodiversity & climate change-related risks and opportunities.

The work is motivated by emerging evidence of a biodiversity crisis in parallel with the climate crisis and the related ongoing discourse on the climate-biodiversity nexus and the need for integrated solutions to deal with both threats simultaneously.

Envision as a sustainability assessment tool can highlight and assess these risks in climate action projects. A prioritization tool for the right projects should enable the identification of win-win projects beyond narrowly focused solutions for rapid outcomes. Finally, it is worth highlighting that the continued work is considered essential in the case of assessing the performance of Nature-based Solutions (NbS).

To proceed with such analysis and given that the research has not yet concluded on 'key criteria' or 'high-priority' Envision credits for integrated biodiversity-climate action, it would be really helpful to receive information on the Natural World Category credits (Credit Documentation Cover Sheets), as they relate to management of biodiversity impacts, risks and opportunities:

Category	Subcategory	Credit
NATURAL WORLD	Siting	NW1.1 Preserve Prime Habitat
		NW1.2 Protect Wetlands & Surface Water
		NW1.3 Preserve Prime Farmland

		NW1.7 Preserve Greenfields
	Land & Water	NW2.2 Reduce Pesticide & Fertilizer Impacts
		NW2.3 Prevent Surface & Groundwater Contamination
	Biodiversity	NW3.1 Preserve Species Biodiversity
		NW3.2 Control Invasive Species
		NW3.3 Restore Disturbed Soils
		NW3.4 Maintain Wetland & Surface Water Functions
	Innovation	NW0.0 Innovate or Exceed Credit Requirements

Thank you in advance for your time.

Overview of the content of received material for projects used as case studies

Projects	Full Envision Assessment Credit Coversheets	Climate change Priority credits coversheets	Reports	Score per credit
CHSR		**Partially** (CR category coversheets)	Sustainability Report Adaptation plan Resilience White Paper	
Santa Monica Clean Beaches	**X**		**X**	
DGUP	**X**			
Dubuque Wind Farm	**X**			
Upland Prairie Wind Farm	**X**			
Berryessa Transit Center	**X**			
Gordie Howe International Bridge	**X**			
Georgetown WWTS		**Partially** (Climate change Priority credits coversheets & NW credits coversheets)		
Historic Fourth Ward Park				**X**

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