

Background Paper Prepared for the 7th Global Policy Forum on Natural Capital

Role of Natural Capital Data, Accounting and Evidence to Inform Biodiversity Policies in Developing Countries

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1. Introduction.

1.1 Biodiversity as a Key Part of Ecosystems

The term biodiversity is defined by the Convention on Biological Diversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”. The same reference source defines an ecosystem as “a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit”¹ and ecosystem services as the benefits people obtain from ecosystems. The focus of much of the literature has been on the nature of these services and their value.

The link between biodiversity and ecosystem services is central to understanding both but is complex. The UN guidance on Environmental-Economic Accounting—Ecosystem Accounting (UN et al. 2021) notes that “biodiversity is integral to the maintenance of ecosystem integrity that is the reference from which the condition of ecosystem assets is assessed.” The condition of ecosystems is key to the valuation of the services of such ecosystems. As the UN Report on Natural Capital Accounting for Integrated Biodiversity Policies notes, ecological and species diversity influence the condition and characteristics of ecosystems (United Nations, 2020). A large body of work involving field experiments, site studies, aerial surveys complemented by mathematical modelling has found that a number of diversity indicators (e.g., covering soil and species diversity) are strongly related to ecosystem productivity (Dasgupta, 2021).

In defining the different components of an ecosystem, biodiversity indicators are mainly present in determining the biotic ecosystem characteristics. Variables that describe species composition, ecosystem structure and ecosystem processes are also used to characterize biodiversity and are therefore considered as essential biodiversity variables. Thus, measures of biodiversity play a critical role in determining ecosystem condition and consequently the value of the ecosystem to the economy.²

This report provides a review of biodiversity trends, drivers of biodiversity loss and how biodiversity policies can help achieve the targets set by the Kunming-Montreal Global Biodiversity Framework (GBF) with the support of the natural capital accounting established by the UNSEEA. The GBF is an outcome of the 2022 United Nations Biodiversity Conference. It aims to halt and reverse biodiversity loss by 2030. Trends in species and ecosystems are summarized below (section 1.2). Section 1.3 lays out the drivers of biodiversity loss and the economic case for nature. Section 2 looks at the role of natural capital accounting in relation to the GBF targets. Section 3 goes into the different policies that can contribute to the GBF targets as well as the tools that are needed to evaluate them. Section 4 focuses on the finance needed to achieve several of the targets and the roles of the public and private sectors in providing that finance.

1.2 Trends in Species and Ecosystems

According to the global assessment of biodiversity and ecosystems services undertaken by IPBES (IPBES, 2019) the overall picture for both biodiversity indicators and ecosystems services is one of deterioration. Global indicators of ecosystem extent and condition show an average decrease of 47

1. www.cbd.int/convention/articles/default.shtml?a=cbd-02

2. Although there is a strong overlap between measures of biodiversity and ecosystem condition, there are also differences. As the Guidance Report observes, there are different spatial and temporal dynamics between individual species and ecosystems. Therefore, not all species or species-based biodiversity indicators are not suitable to assess condition at all scales.

per cent from their estimated natural baselines, with many continuing to decline by at least 4 per cent per decade. Furthermore, the decline is higher in areas where the biodiversity is greater such as terrestrial “hotspots” of endemic species. Globally, while net rate of forest loss has halved since the 1990s this has been largely because of net increases in temperate and high latitude forests; high-biodiversity tropical forests continue to dwindle, and global forest area is now approximately 68 per cent of the estimated pre-industrial level. Inland waters and freshwater ecosystems show among the highest rates of decline. Only 13 per cent of the wetland present in 1700 remained by 2000; recent losses have been even more rapid (0.8 per cent per year from 1970 to 2008).

In marine ecosystems seagrass meadows have decreased in extent by over 10 per cent per decade from 1970 to 2000. Live coral cover on reefs has nearly halved in the past 150 years, the decline dramatically accelerating over the past two or three decades due to increased water temperature and ocean acidification interacting with and further exacerbating other drivers of loss. These coastal marine ecosystems are among the most productive systems globally. Their loss and deterioration reduce their ability to protect shorelines, and the people and species that live there, from storms, as well as their ability to provide sustainable livelihoods. Severe impacts to ocean ecosystems are illustrated by 33 per cent of fish stocks being classified as overexploited.

The global rate of species extinction is already at least tens to hundreds of times higher than the average rate over the past 10 million years and is accelerating. Human actions have already driven at least 680 vertebrate species to extinction since 1500. The threat of extinction is also accelerating: in the best-studied taxonomic groups, most of the total extinction risk to species is estimated to have arisen in the past 40 years.

Domestic varieties of plants and animals are the result of natural and human-managed selection, sometimes over centuries or millennia, and tend to show a high degree of adaptation (genotypic and phenotypic) to local conditions. As a result, the pool of genetic variation which underpins food security has declined. Many hotspots of agrobiodiversity and crop wild relatives are under threat or not formally protected. The conservation status of wild relatives of domesticated livestock has also deteriorated. These wild relatives represent critical reservoirs of genes and traits that may provide resilience against future climate change, pests and pathogens and may improve current heavily depleted gene pools of many crops and domestic animals. Available data suggest that genetic diversity within wild species globally has been declining by about 1 per cent per decade since the mid-19th century; and genetic diversity within wild mammals and amphibians tends to be lower in areas where human influence is greater. Figure 1 provides an overview of the global indicators of natural ecosystem structure. It shows decadal declines in most indicators as well as an overall fall relative to pristine conditions for many of them.

1.3 Drivers of Biodiversity Loss and Economic Case for Biodiversity

The drivers of biodiversity loss are separated into the direct and indirect (IPBES, 2019). The direct drivers listed are: (a) industrial fishing, which has a footprint four times larger than agriculture, (b) agriculture, including grazing, which has immense impacts upon terrestrial ecosystems, with important differences depending upon enterprise’s intensity and size, (c) reductions in forest cover which totalled 290mn has during 1990 to 2015, (d) harvesting of wild plants and animals from land and seascapes, (e) mining, which has risen dramatically, with big impacts on terrestrial biodiversity hotspots and global oceans, mostly in developing areas with weaker regulation and (f) construction of dams, roads and cities, which have strong negative impacts on nature, (g) airborne and seaborne transportation of goods and people has risen dramatically, causing both increased pollution and a significant rise in invasive alien species, (h) Illegal extraction – including fishing, forestry and poaching – adds to unsustainability, yet is fostered by markets (local, global) and poor governance.

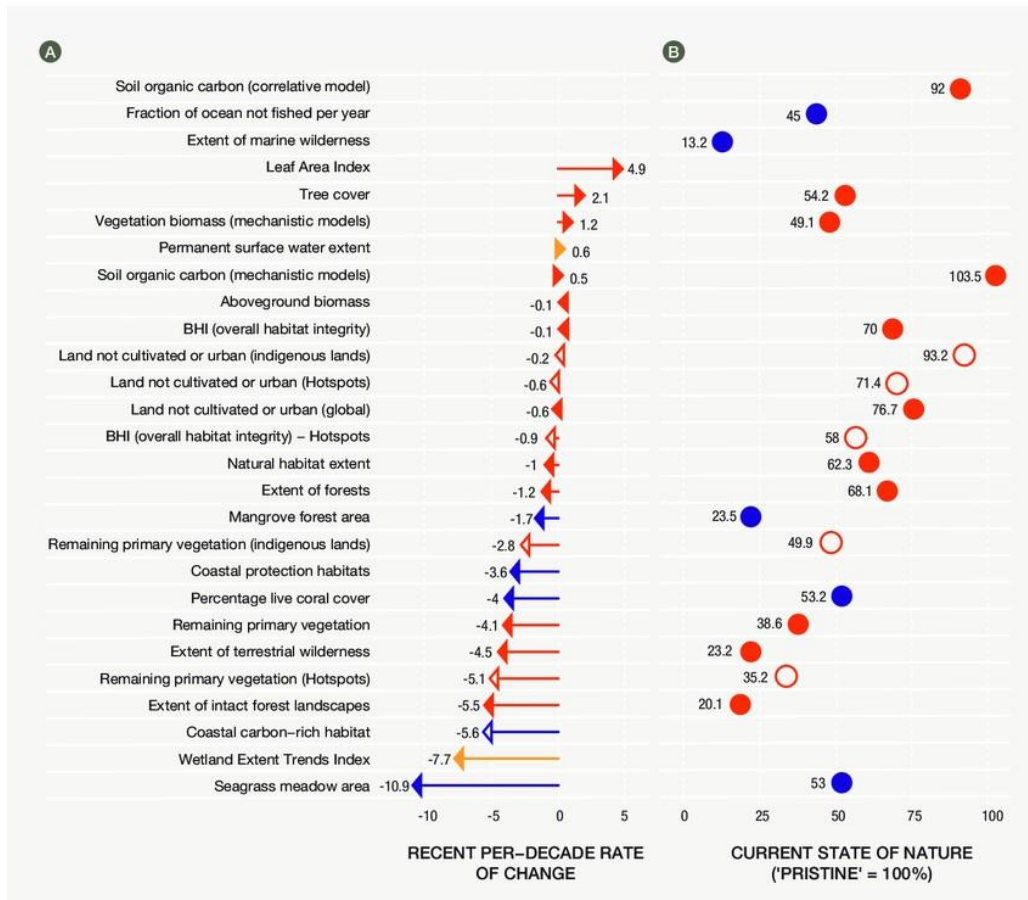
The indirect drivers of loss identified by IPBES are: (a) values (the way nature is conceived and valued), (b) demography (increase in population is a big factor in scales of degradation), (c) loss of indigenous knowledge for managing nature, (d) migration and urbanisation and (e) expanding trade resulting in greater impacts on nature in low-income countries.

While these drivers are pertinent to any analysis of the causes of and solutions to biodiversity loss, one goes further and can ask what are the **underlying** economic and institutional factors behind these drivers? Here a number of market failures stand out. As has been noted by Dasgupta (2021; 2022) and others, subsidies to exploit nature play a major part. Governments have been spending around \$700 billion a year on agricultural subsidies, \$35 billion on fishery subsidies and \$4-6 trillion on energy subsidies. These cause more damages to ecosystems than the benefits they provide to the recipients of the subsidies (see section 3.2 for further details). The second underlying factor is that much of the biodiversity is part of the global commons, such as oceans and tropical rainforests, that provide benefits to everyone on the planet but are de facto open access resources and not managed for sustainable global benefits. Some are not managed at all, while others are under national jurisdiction where national rather than global objectives determine the way they are exploited. Third, is the nature of international trade, which includes a lot of exports of nature-based products from developing countries to developed ones. These exports cause losses of biodiversity in the countries of origin that are not accounted for in the prices paid for the exports. Thus, the exporting countries suffer a loss (along with the global community to some extent) but the importing rich countries gain more than they would if the costs in terms of losses were accounted for (Dasgupta (2022)). Because of these market and institutional failures, biodiversity and essential ecosystem services (e.g., regulating services) are not adequately priced and integrated into mainstream economic decisions. Loss of nature and biodiversity often remains unaccounted and not reflected in the countries' national system of accounts or in the firms' balance sheets. As a result, existing metrics for measuring growth and economic performance such as GDP do not capture the social costs associated with the depletion of renewable natural capital including loss of biodiversity and ecosystem services. These underlying factors are at the root of the direct drivers identified in the IPBES report.

The losses of biodiversity and degradation of ecosystems matter because they impact on the ecosystem services that provide benefits to people. The IPBES refers to these as Natures Contributions to People and its review of trends indicates that in 14 of 18 categories under which biodiversity and ecosystems make such contributions, there has been a decline from 1970 to the present (IPBES, 2019)³. Only three categories – Energy, Food and Feed and Materials and Assistance have had an increase over this period and one – regulation of ocean acidification – has remained stable (Figure 2).

³ The categories are: Habitat creation and maintenance, Pollination, Regulation of air quality, Regulation of climate, Regulation of ocean acidification, Regulation of freshwater quantity and Freshwater and coastal water quality, Protection and decontamination of soils, Regulation of extreme events, Regulation of detrimental organisms and biological processes, Supply of energy, Supply of food, Supply of materials, Supply of medicinal, biochemical and genetic resources, Learning and inspiration, Physical and psychological experiences, Supporting identities and Maintenance of options (IPBES, 2019 Figure SPM 1).

Figure 1: Global Indicators of Natural Ecosystem Structure



Source: IPBES (2019)

Figure 2: Global trends in the capacity of nature to sustain contributions to quality of life: 1970 to the present.

Nature's Contribution	50-Year Global Trend	Direction Across Regions	Selected Indicator
1. Habitat creation and maintenance	↓	Consistent	Extent of suitable habitat Biodiversity intactness
2. Pollination	↓	Consistent	Pollinator diversity Extent of natural habitat in ag areas
3. Air Quality Regulation	↘	Variable	Retention of emissions of air pollutants by ecosystems
4. Climate Regulation	↘	Variable	Prevented emissions of GHGs by ecosystems
5. Regulation of ocean acidification	→	Variable	Capacity to sequester carbon by marine & terrestrial systems
6. Regulation of freshwater quantity, location and timing	↘	Variable	Ecosystem impact on air-surface-ground water partitioning
7. Regulation of freshwater and coastal water quality	↘	Variable	Extent of ecosystems that filter or add components to water
8. Formation, protection and decontamination of soils	↘	Variable	Soil organic carbon

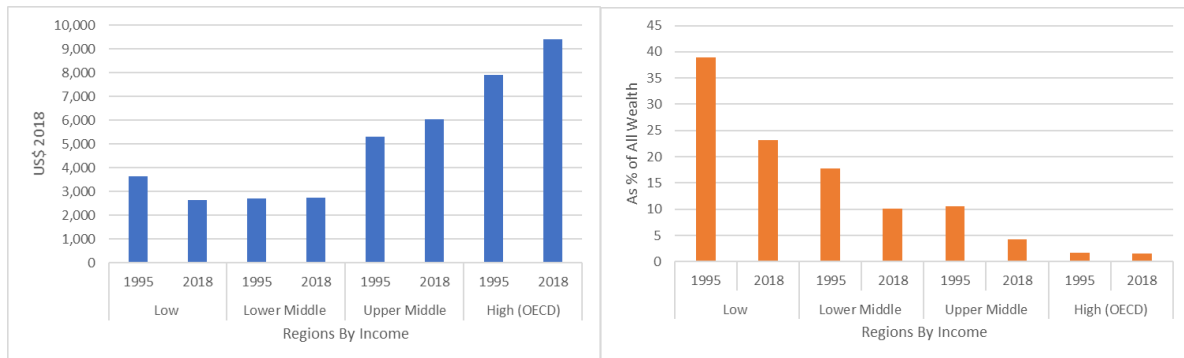
9. Regulation of hazards and extreme events	↘	Variable	Ability of ecosystems to absorb and buffer hazards
10. Regulation of detrimental organisms and biological processes	↓ ↘	Consistent	Extent of natural habitat in agricultural areas Diversity of competent hosts of vector borne diseases
11. Energy	↗ ↘	Variable	Extent of agricultural land for bioenergy Extent of forested land
12. Food and Feed	↗ ↓	Variable	Extent of agricultural land for food and feed Abundance of marine fish stocks
13. Materials and Assistance	↗ ↘	Consistent	Extent of agricultural land for material production Extent of forested land
14. Medicinal, biochemical and genetic resources	↘ ↓	Consistent	Fraction of species known and used medicinally Phylogenetic diversity
15. Learning and inspiration	↓ ↓	Consistent	No or people in close proximity to nature Diversity of life from which to learn
16. Physical and psychological experiences	↘	Consistent	Area of natural and traditional landscapes and seascapes
17. Supporting identities	↘	Consistent	Stability of land use and land cover
18. Maintenance of options	↓ ↓	Consistent	Species' survival probability Phylogenetic diversity

Source: IPBES (2019)

The contributions of nature are quantified in monetary terms where possible through the concept of **natural capital**, which is defined as: “that part of nature which directly or indirectly underpins value to people, including ecosystems, species, freshwater, soils, minerals, the air and oceans, as well as natural processes and functions”⁴. As with all forms of capital assets, the value is given as the present value of the flow of services that the asset provides over its lifetime, which may be infinite for an ecosystem that is maintained in a sustainable condition. It is divided between renewable natural capital (in the form of services from forests, fisheries, mangroves, and agriculture) and along non-renewable natural capital (i.e., sub-soil assets based on fossil fuels, minerals etc.).

Using this approach estimates have been made of the value of renewable natural capital, which is the form closely related to biodiversity. The World Bank Comprehensive Wealth Accounting (World Bank, 2021) estimated for all countries the values of renewable and non-renewable natural capital, produced and human capital over the period 1995 to 2018. Renewable natural capital made up 4.3% of all capital in 1995 but this declined to 3.1% by 2018. Figure 3 gives the amounts of per capita renewable natural capital for different income regions over this period as well as the share it makes up of all forms of capital.

⁴ [Natural Capital Terminology \(publishing.service.gov.uk\)](https://publishing.service.gov.uk)

Figure 3: Renewable Natural Capital by Region

Source: World Bank (2021)

While the total value of renewable natural capital increased in all regions, in *per capita* terms it declined significantly in the low-income region. The decline was particularly sharp in sub-Saharan Africa (by 42%). This will likely impact most of low-income and vulnerable rural households in that region. Furthermore, “blue natural capital” (fishery and mangroves) declined globally by half over the same period, mainly because of a collapse in the value of fishery of 83%. Despite the fall in *per capita* terms, natural capital remains a large part of all wealth in low-income countries. These estimates of natural capital are not complete (several marine ecosystems are not covered, for example), but the figures show the importance of natural capital and places where its loss is a matter of concern.

A study that focused on biodiversity loss specifically used an index referred to as mean species abundance (MSA), which reflects the impact of loss of species relative to pristine conditions on the services that ecosystems can provide within different biomes. It is a metric of ecosystem condition in the SEEA EA accounts, in particular of ecosystem compositional characteristics. Such “MSA adjusted areas” have been estimated for different biomes across the world and over time, going back to 1900 and even earlier in the biodiversity modelling work undertaken by the GLOBIO3 team in the Netherlands (Alkemade et al., 2009). Estimates have also been made of the likely loss of ecosystem services by 2050 if no action is taken. In a Costs of Policy Inaction study, Braat and ten Brink (2008) calculate those monetary losses will run at around one per cent of GDP in 2050 and cumulative losses from 2000 to 2050 will be around 7% of 2050 consumption.

While inaction to biodiversity loss will result in significant economic costs, an ambitious program, with the right policies, can avoid such losses. Leclère et al. (2020) use an ensemble of land-use and biodiversity models to assess whether—and how—the declines to biodiversity through habitat conversion can be reversed. They show that a program to increase the extent of land under conservation management, restore degraded land and generalize landscape-level conservation planning, biodiversity trends from habitat conversion could become positive by the mid-twenty-first century on average across models (confidence interval, 2042–2061), but not for all models. Food prices could increase and, on average across models and almost half (confidence interval, 34–50%) of the future biodiversity losses could not be avoided. However, additionally tackling the drivers of land-use change could avoid conflict with affordable food provision and reduce the environmental effects of the food-provision system. Through further sustainable intensification and trade, reduced food waste and more plant-based human diets, more than two thirds of future biodiversity losses could be avoided and the biodiversity trends from habitat conversion are reversed by 2050 for almost all of the models.

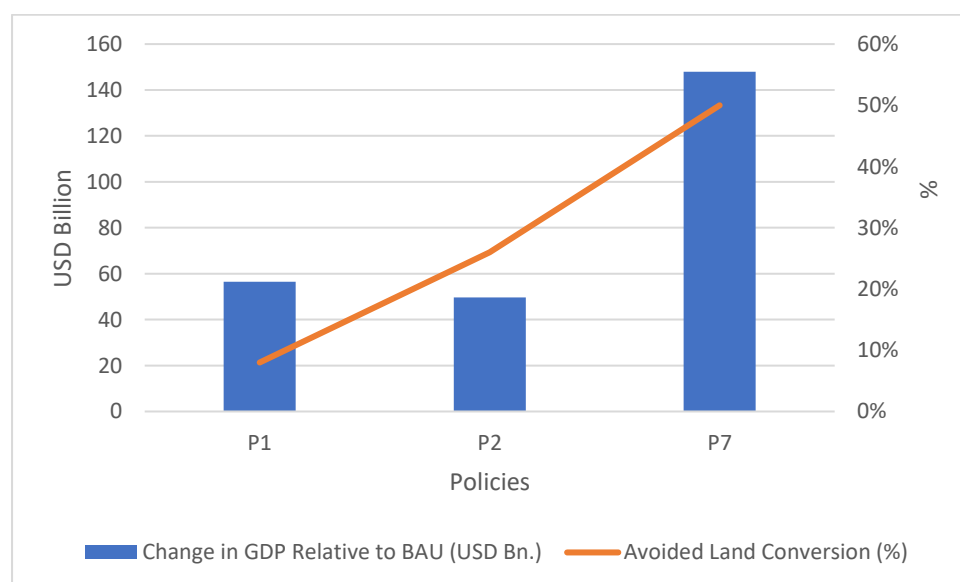
From a more economic perspective, a World Bank study on the Economic Case for Nature (World Bank, 2021a) has looked at the impact of the loss of ecosystem services under business as usual

from pollination, provision of timber, food from marine fisheries, and carbon sequestration by forests (thus covering more than just biodiversity loss). They estimate these losses to result in a fall of global GDP growth of 2.3% or US\$2.7 trillion between 2021 and 2030, with the loss in low-income countries' growth being as much as 10%. On the other hand, if a set of policies are put in place, up to half these losses can be prevented. The policies consist of: (a) repurposing public sector support to economic activities such as agriculture, so that such support is not linked to current or future production volume or value, thus removing incentives to maintain marginal land in production; (b) create incentives for conservation, for example by paying landowners in exchange for the protection of forest carbon sinks and (c) increase public investment in agricultural research and development (R&D) as an incentive to increase output on existing agricultural areas, rather than expanding cultivated areas (Figure 4).

The modelling shows that even ambitious targets, such as protecting 30 percent of the planet by 2030 (the “30x30” goal, which is relevant to GBF target 3) have economic benefits. When combined with the most conservation-effective of the policy scenarios, achievement of the 30x30 goal results in a 0.1 percent decline of global GDP in 2030, compared with business-as-usual.

Central to these analyses is data on the value of ecosystem services at a highly spatially disaggregated level. The collection and consistent reporting of such information, which is also key to Goal B of GBF, has to be made for all countries and Natural Capital Accounting in accordance with the UN guidelines provides the framework for that. The next section lays down what the SEEA consists of and the way in which it can be used to evaluate biodiversity policies and target linked to the Global Diversity Framework.

Figure 4: Change in Global GDP and avoided conversion of natural land compared with business-as-usual, by policy



P1: Repurpose public sector support to economic activities such as agriculture, so that such support is not linked to current or future production volume or value, thus removing incentives to maintain marginal land in production

P2: Create incentives for conservation, for example by paying landowners in exchange for the protection of forest carbon sinks. This can be done through domestic carbon payment schemes or a global scheme. Here a domestic scheme is assumed.

P7: This is P1 plus P2 but with a global carbon payment scheme and an increase public investment in agricultural research and development (R&D) as an incentive to increase output on existing agricultural areas, rather than expanding cultivated areas.

Source: World Bank (2021a)

2. Natural Capital Accounting (NCA) and Biodiversity Policies and Targets.

2.1 NCA and the SEEA Accounting Systems

The information requirements surrounding biodiversity policy questions require a large amount of data. Data on ecosystems, and the services that they provide is of vital importance, as is data on species occurrence. This information is delivered in a coherent and comparable form by the UN SEEA. As UN statistics division notes:

“The System of Environmental-Economic Accounting (SEEA) is the accepted international statistical standard for NCA and provides a framework for organizing and presenting statistics on the environment and its relationship with the economy. Placing environmental statistics into an accounting framework dramatically increases their usefulness for policy, enabling international comparability, replication over time, and straightforward integration with existing national accounts. Importantly, the SEEA is well aligned with national accounting principles, namely those used in the System of National Accounts (SNA), from which GDP and other mainstream macroeconomic indicators are derived. This relationship between the SEEA and the SNA allows the SEEA to provide a coherent set of statistics on the environment-economy nexus that can easily be integrated into policy analysis.” (United Nations, 2020, Page 26).

The SEEA consists of two parts: The SEEA Central Framework (SEEA-CF) and the SEEA Ecosystem Accounting Framework (SEEA-EA).

SEEA-CF. This registers information on individual environmental assets such as energy, water, fish and timber, providing information on how they are extracted from the environment, used in the economy, and returned to the environment in the form of waste, water and air emissions. It allows for the integration of environmental information (often measured in physical terms) with economic information (often measured in monetary terms). The power of the SEEA Central Framework comes from its capacity to present information in both physical and monetary terms coherently. Data relevant to biodiversity policies in this framework include supply and use tables which record the flows of natural inputs (e.g., minerals, timber, fish and water), products and residuals (e.g., solid waste, air emissions and return flows of water) in both physical and monetary terms across different sectors in the economy as well as those entering and leaving the economy. The framework also records stocks and changes in stocks of environmental assets (e.g., water, timber, fish, minerals and energy resources etc.) in physical and monetary terms. Finally, the framework also records transactions taken to preserve and protect the environment.

SEEA-EA. The second part complements the SEEA-CF by taking the perspective of ecosystems. The SEEA EA constitutes an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. It enables the presentation of indicators of the level and value of ecosystem services in a given spatial area. The SEEA EA is built on five core accounts, i.e., ecosystem extent, ecosystem condition, physical and monetary ecosystem services flow, and monetary ecosystem asset accounts. These accounts are compiled using spatially explicit data and information about the functions of ecosystem assets and the ecosystem services they produce.

In the SEEA EA ecosystem assets are areas covered by specific ecosystem types such as forests, wetlands, agricultural areas, rivers, coral reefs etc. The physical accounts have been adopted by the UN Statistical commission as international statistical standard in 2021, while the monetary accounts represent internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets. A defining characteristic of ecosystem accounting is that it is spatially

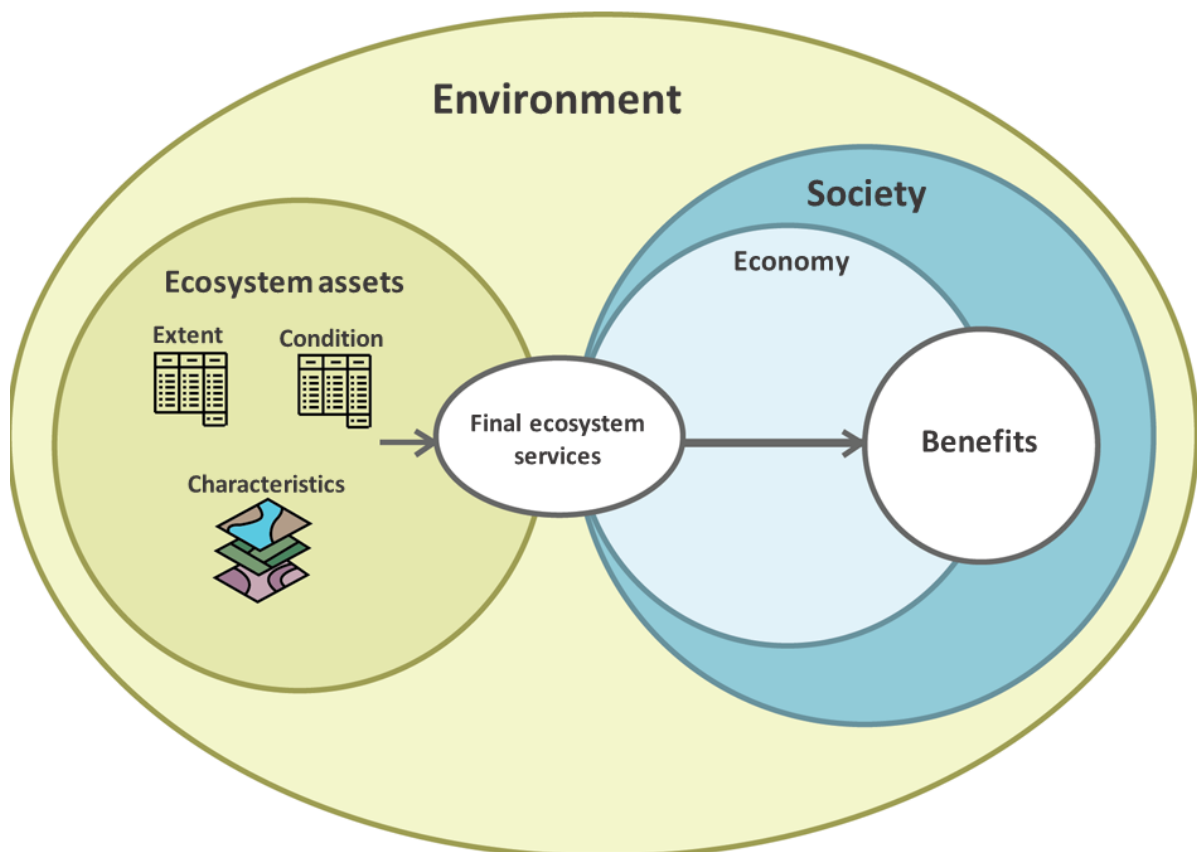
explicit, i.e., it builds accounts based on underlying maps with information. As such, ecosystem accounting produces an integrated spatial information system.

Ecosystem extent accounts provide information on the extent of different ecosystem types within a country in terms of area. In particular, they describe the environment in terms of sets of mutually exclusive (i.e., nonoverlapping) ecosystem assets. All assets together populate an ecosystem accounting area, which could range from a watershed in a municipality, a country etc. The extent account describes the various types of ecosystems that are distinguished within an area and how they change over time.

Ecosystem condition accounts measure the overall quality of an ecosystem asset and capture, in a set of key indicators, the state of the ecosystem in relation to both its naturalness and its potential to supply ecosystem services. The condition account compares different years to track changes over time. Condition accounts provide valuable information on the health and state of ecosystems and their capacity to deliver critical ecosystem services in the future.

The conceptual model underlying ecosystem accounts is shown in Figure 5. The model starts with identifying ecosystem assets - an ecosystem that is mapped by mutually exclusive spatial boundaries such that each asset is classified to a single ecosystem type. Assets are described through their extent and condition. The information on the ecosystem assets is used to estimate the final ecosystem services, which are the contributions of ecosystems to the benefits. Some ecosystem services are reflected in the economic accounts (e.g., crop provisioning), whereas others are not (e.g., water purification). Finally, the benefits from the ecosystem services form part of the measured individual and social well-being.

Figure 5: SEEA-EA. Conceptual Model



Source: United Nations et al. 2021 Figure 2.1

The link between the environment and society sides of the concept is presented in the **ecosystem services flow accounts**. These measure the supply of ecosystem services as well as their corresponding use and beneficiaries, classified by economic sectors used in the national accounts, in both physical and monetary terms. SEEA EA uses the following three broadly agreed categories of ecosystem services:

- Provisioning services (e.g., supply of food, fibre, fuel and water);
- Regulation and maintenance services (related to activities of filtration, purification, regulation and maintenance of air, water, soil, habitat and climate); and
- Cultural services (related to activities of individuals in, or associated with, nature, such as recreation).

Ecosystem services are defined in SEEA EA as the contribution to benefits, rather than as the benefits themselves, in order to avoid double counting. For example, an agricultural crop such as corn or maize is already recorded in the national accounts. Moreover, corn is the result of combining human capital (in the form of labour), produced capital (machinery) and natural capital (the cropland). The objective of the ecosystem services accounts is to isolate the contributions of nature to the production of the crop. By expanding the national accounts production boundary, the accounts also recognize a range of ecosystem services that lead to benefits that are not currently recognized in the SNA such as carbon sequestration or air filtration. It is also worth noting that the SEEA EA follows the valuation concept of exchange values, same as is applied in the SNA to allow for comparability and integration with national accounts.

Finally, the monetary side of the ecosystem services flow accounts feeds into the asset account, which records the monetary value of opening and closing stocks of all ecosystem assets within a given ecosystem accounting area, as well as additions and reduction to those stocks. The value of the ecosystem assets are estimated by discounting annual flows of services over the projected period i.e., the expected lifetime of the ecosystem, using a so-called net present value method. In order to estimate these projected service flows, it is important to take into account the capacity of the ecosystems to sustain these service flows which will depend on their condition and the extent to which these ecosystems are sustainably managed, and if not, make corrections to future service flows. Thus, the valuation of ecosystem assets allows an assessment of a more comprehensive measure of wealth of a country (in addition to produced capital, financial capital etc.).

2.2 Use of NCA in Relation to Global Biodiversity Framework (GBF) Targets

There are two headline indicators in the GBF where UNSD has a lead role. These are: (a) Goal A A.2 Extent of Natural Ecosystems by Type; (b) Goal B B.1 Functions and Services Provided by Service Type. In addition, NCA plays an important part in guiding policies and resources to the achievement of several targets.⁵ These are detailed in Table 1. The key role of NCA is in providing information to undertake an evaluation of policies and investments related to the different targets. Benefits of meeting the targets result in an increase in ecosystem services that can only be measured if data on the baseline services and their dependence on condition are available. These benefits determine priorities of where action should take place to meet the targets and in designing measures that yield the greatest net benefits. Data on ecosystem condition are also important in determining sustainable exploitation rates for renewable resources and in setting regulations on harvesting and trade. In addition, data on biodiversity indicators is the basis for biodiversity credits and other markets, which derive biodiversity 'units' based on these indicators. The ecosystem condition accounts provide important information for this purpose.

⁵ Only 15 of the 23 targets are listed in the table. The 8 where the links to NCA are indirect or incidental have been left out.

Table 1: GBF Targets and the Role of NCA

Targets	Policies and Actions on Fiscal Liabilities	Role of NCA
2 & 3. Ensure that by 2030 at least 30% of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration. Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed.	Setting up of protected areas and effective management Supply of biodiversity services. Support creation of markets for such services Promote eco-tourism where appropriate	Priorities of areas for restoration should be determined on the basis of those that will generate the greatest net increase in ecosystem services. Valuing these services using the SEEA-EA spatial data sets will be critical to the selection. (United Nations, 2020). Conservation and management of areas involves restricting their use for some activities, which has an opportunity cost that needs to be estimated based on integrated SEEA data. Management programs can increase ecosystem services, valuing which requires the SEEA-EA.
4. Halt human induced extinction of threatened species and take actions for Recovery and conservation of species, in particular threatened ones. Maintain and restore genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential. Effectively manage human-wildlife interactions to minimize human-wildlife conflict for coexistence.	Control of trade and prevent unsustainable use of species. Record genetic materials. Create in-situ and ex-situ conservation facilities. Property rights for genetic materials.	Ecosystem service accounts include services from the presence of particular species in a given landscape but at present do not include genetic diversity. Efforts to develop a full methodology for species and genetic accounts are currently being undertaken. These will form part of the information required to determine effective management programs.
5 & 9. Ensure harvesting and trade of wild species is sustainable, safe and legal, preventing overexploitation, minimizing impacts on non-target species and ecosystems.	Regulate trade in species. Design policies for sustainable use	Data on ecosystem condition provide the basis for determining sustainable rates of exploitation for the system as a whole. This is key to setting harvesting and trade regulations.
6. Minimize or mitigate the impacts of invasive alien species on biodiversity and ecosystem services. Reduce the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent by 2030.	Regulate entry of invasive species	Damages from alien species to different ecosystems have been derived in part from national ecosystem condition accounts (Cuthbert et al., 2021). This provides the basis of where to prioritize actions to minimize and mitigate the impacts of such species.
7. Reduce pollution risks from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services: (a) by reducing excess nutrients lost to the environment by at least half; (b) by reducing the overall risk from pesticides and highly hazardous chemicals by at least half; and (c) by preventing, reducing, and working towards eliminating plastic pollution.	Use economic instruments to reduce pollution (Charges, PES, Repurposing subsidies) Regulations on use of harmful materials.	Estimates of damages from excess nutrients and pesticides on ecosystem services have been made based on ecosystem extent and condition accounts (Lord, 2023). These will help determine where priority should be given to actions to meet the quantitative targets. SEEA CF Accounts for drivers will play a key role here.
10. Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices	Targeted subsidies as well as taxes and direct controls to prevent overuse.	Making food systems truly account for the costs of production and distribution is a key objective. Designing and evaluating these requires data on how reforms can reduce the costs for other ecosystem services. Starting point for all this is provided by national NCAs.

Targets	Policies and Actions on Fiscal Liabilities	Roles of NCA
11. Restore, maintain and enhance nature's contributions to people, through regulation of air, water and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters	Mix of regulatory and fiscal policies as well as investment in clean technologies	NCA provides data on regulatory Functions and Services Provided by Ecosystems by Service Type.
12. Significantly increase the area and quality, and connectivity of, access to, and benefits from green and blue spaces in urban and densely populated areas sustainably, by mainstreaming the conservation and sustainable use of biodiversity	Investment in green and blue spaces based on environmentally-extended cost benefit analysis	Gains in ecosystem services from quality improvements in urban areas have been estimated based on NCA in the Netherlands and UK among other countries. This shows the way in which different programs can be justified on cost benefit grounds. NCAVES and MAIA (2022).
14 and 21. Ensure the integration of biodiversity values into policies, regulations, planning and development processes, poverty eradication strategies, strategic environmental assessments, environmental impact assessments and, as appropriate, national accounting, within and across all levels of government and across all sectors. Ensure the best available data, information and knowledge are accessible to decision makers, practitioners and the public to guide effective and equitable governance and management of biodiversity. Traditional knowledge, of indigenous peoples and local communities should only be accessed with their free, prior and informed consent.	Use of environmentally-extended cost benefit analysis Use economy-wide models to evaluate policies and programs and include biodiversity targets in such models.	The core of doing this is to make NCA available to policy analysts and decision-makers and to provide support in the use of such accounts for the kinds of decisions mentioned in the Target. At present the value of traditional knowledge and practices is not fully reflected in ecosystem services nor in national biodiversity strategies and action plans, where only 40 Parties report that indigenous people and local communities have been involved (Secretariat of the Convention on Biological Diversity, 2020). More work is needed to include these in determining the value of such services, especially those related to properties of fauna and flora in low-income countries.
15. Take measures to encourage and enable business to ensure that: (a) large and transnational companies and financial institutions regularly monitor, assess, and disclose their risks, dependencies and impacts on biodiversity; (b) provide information needed to consumers to promote sustainable consumption patterns; (c) report on compliance with access and benefit-sharing regulations and measures.	Develop biodiversity metrics Create markets for biodiversity credits	One of the challenges for companies is how to measure biodiversity performance. A number of biodiversity measurement approaches for businesses or financial institutions are available or currently in development, drawing in part on indicators of ecosystem condition (United Nations 2020). The SEEA accounts also derive data from businesses thus engaging them in relevant data collection.
19. Increase the financial resources from all sources in an, including domestic, international, public and private resources, in accordance with Article 20 of the Convention, to implement national biodiversity strategies and action plans, mobilizing at least \$200 billion per year by 2030.	Markets for biodiversity credits. Green bonds. Reduce risks for supplies of biodiversity through risk sharing by donors and IFIs	Making the case for financial resources requires information on the benefits of different programs, which draw on national NCA accounts. In addition, markets for biodiversity credits are based on measures of biodiversity indicators that draw in part from ecosystem condition accounts (Ducros and Steele, 2022; Biodiversity Credit Alliance, 2023).

3. Policies to Conserve Biodiversity and Tools to Assess Them

The measures taken and investments made to conserve biodiversity fall broadly into the following groups:

- A. Regulatory and information sharing
- B. Investment in conservation and restoration of degraded land and marine areas
- C. Use of economic instruments at the micro level
- D. Incentives and strategic choices at the economy-wide and sectoral level.

3.1 Regulatory and Information Sharing

The largest area of regulations relate to protected marine and terrestrial areas but rules are also needed to determine extraction of biodiverse natural resources and trade in them, including endangered species; and property rights on genetic materials maintenance of biological corridors and other land use codes of practice. Pollution emissions to the environment also impact biodiversity. Guidance is also given by governments to encourage agricultural practices that are more friendly to biodiversity.

Protected areas (PAs) and Other Conservation Measures

These were given a major boost through with the inclusion of 30x30 in Target 3 of the GBF (i.e., a commitment to conserve 30% of terrestrial, inland water, coastal and marine areas by 2030). Previous work has shown that under conventional management of such areas the benefit to cost ratios of declaring areas protected are often quite low (Hussain et al. 2011). This is partly because many of the benefits of declaring such areas are not being realized and partly because of poor management. In a detailed study on PAs in South Asia Clarke et al (2013) found that in many cases there was no modification at all and management schemes were not working. To make this assessment spatially explicit data is needed on the extent to which PA ecosystems are changing and improvements or declines in their condition. Such data needs to be systematically collected and standardized as is done in NCAs data, and the ecosystem services that are being gained or lost.

With the use of data on ecosystem service values and natural capital, the potential biodiversity-related benefits of PAs can be identified and realized by: (a) promoting eco-tourism, (b) managing the genetic value of biodiversity in these areas and trading it through equitable agreements, (c) introducing biodiversity credit markets where third parties pay for conservation of defined areas with high biodiversity (d) retraining communities dependent on the protected areas and local governments that support them to provide these services. In setting all such policies, physical data on ecosystem condition and carrying capacity will be required. There will be a role for the private and public sectors in creating the supply of these services and for International Financial Institutions (IFIs) in providing technical and financial support.

A good example of the kind of analysis that informs policy on protected and conservation areas is the one for Kenya's wildlife, which is a key source of income from tourism (Damania et al., 2019). There has been a decline in numbers, however, with more than half the wildlife biomass being lost in the past three decades. This has been taking place both inside the national parks as well as outside these protected areas. This report uses a variety of approaches to investigate the economic consequences of this decline. State-of-the-art spatial econometric methods are used to identify the causal drivers of the loss and quantify the impacts on wildlife. A Computable General Equilibrium (CGE) model is used to estimate the economic consequences of wildlife loss and compare these consequences to alternative development pathways. Finally, spatial algorithms are developed to show how losses can be avoided and how to create win-win solutions that maximize economic gains. All these tools draw on ecosystem data of the kind the SEEA EA seeks to provide. The study finds rural road construction to be a major driver of wildlife loss. As it is also an important factor for development, there is a trade-off. The analysis shows that in some parts of the country the loss of

wildlife has a greater cost to the economy than the gain from the road construction. Moreover, development opportunities exist to harness the dual benefits of both conservation and development: if the consequences of construction were managed and controlled better so that habitat conversion was prevented and wildlife losses avoided, it should be possible to simultaneously obtain the benefits of infrastructure development as well as those brought by tourism.

Other work at the World Bank has shown that investment in tourism can generate significant benefits to the local economy but has to be managed in terms of costs imposed to some households (World Bank (2021c). Four country case studies were undertaken: two in terrestrial protected areas in Zambia and Nepal, and two in marine protected areas in Fiji and Brazil to evaluate the impacts of investments in tourism in the areas. Contributions to the economy were direct in the form of visitor spending on park fees, hotels, transport, leisure and recreation, which create employment and support local businesses; while indirect effects occur when tourism businesses and employees further stimulate economic activity by using the services of other local businesses. These direct and indirect impacts converge on an income multiplier, which is defined as the change in local household incomes per unit of money entering the local economy through tourist spending, and is a measure of economic impact. A general equilibrium model known as LEWIE – Local Economy-Wide Impact Evaluation was adopted to estimate these multipliers. The main findings were: (a) tourism in protected areas generates significant income multipliers in all country cases, showing that local market linkages are strong, and amplify tourist spending; (b) benefits are broad and help the poor; (c) significant job opportunities are created directly: through tourism activities, and indirectly by stimulating local economies. At the same time, protected areas can impose costs on communities which must be managed. Human-wildlife conflict around terrestrial protected areas, and fishing restrictions in marine protected areas, can cause critical short-term income loss to households which should be mitigated through avoidance measures and timely compensation. Overall, they find that public investment in protected areas pays off, and generates high economic returns. Rates of return on government spending are significantly greater than one -- around \$6.2–\$28.2 for every public dollar invested. Together, these findings make the case for governments to promote sustainable and inclusive tourism in protected areas to stimulate economic growth and create jobs.

Extraction of Biodiverse-Rich Natural Resources

To protect biodiversity, governments need to manage the rate of exploitation of natural resources such as fish, forest products and the like. Regulations are set to limit catch or extraction to a sustainable level, either by quantitative limits for different agents or through market-based mechanisms (see below). In either case this requires information on both the impacts of current rates of extraction on the stock and what rates are sustainable in the long term. The NCA accounts collect relevant data when estimating the present value of these resources. The values of the stocks depend in part on how current rates of exploitation affect future stock levels and what rates will be exploited in the future. Estimation for agricultural biomass, forest resources and fisheries in the context of estimating wealth accounts has been made by the World Bank (World Bank, 2021, Appendix A) and by UNEP (Managi and Kumar, 2018). Guidance on the use of the methods is available in NCAVES and MAIA, 2022. Policies to ensure sustainable exploitation require such data, to set limits on use.

Policies also determine trade in natural resources, especially in endangered species, which is subject to substantial controls. Although there has been a significant increase since 2010 in the number of countries with national legislation meeting the requirements of the Convention on International Trade in Endangered Species (CITES), reaching 101 countries (55% of CITES Parties) by 2019, an increase of 20 countries in the past decade, nearly half of all countries have not yet put in place the laws and regulations required to control such trade (Secretariat of the Convention on Biological

Diversity (2020)). In some cases, a clear ban on trade is required (e.g., items on the Red List) but in others some trade may be possible if controlled at sustainable levels of exploitation.

Genetic Materials

Loss of genetic material and diversity is a matter of great concern to the GBF. Policy decisions to maintain stocks of material can be supported by enhancing adaptive evolution of species that are beneficial (e.g., keystone species or species with important benefits to people) and reducing the adaptive evolution of species that are detrimental (e.g., pests, pathogens, weeds) (IPBES. 2021). As noted in Table 1, the NCA accounts do not contain data on genetic material, although this is being introduced. Yet it is known that such materials have significant economic values, estimated at around US\$850 billion in 2006 for: pharmaceutical products, biotechnology, crop protection products, agricultural seeds, ornamental horticulture and Personal Care, Botanical and Food & Beverage Industries (Laird and Wynberg, 2008). They can provide sustainable livelihoods for rural communities if rents from their sustainable exploitation can be captured. Estimates of these rents vary with studies indicating values of a few dollars per hectare (OECD, 2004). Present arrangements, however do not ensure that even these are transferred to local communities. Furthermore, the estimates of rents are based on private values of the products: for some of them, such a pharmaceutical drugs social values are much higher. It has been suggested that if rents could be based on the willingness to pay for drugs derived from such materials the rents could be two orders of magnitude higher (Craft and Simpson, 2001).

Researchers have looked at ways of raising the economic value and the possible rent from genetic resources to owners: (a) improve prior information on quality of material, (b) reduce the transaction costs between the supplier and the consumer of genetic material (c) create increased bargaining power on the side of the countries where genetic resources are located, (d) recognizing property rights for traditional knowledge.

3.2 Investment in restoration of degraded land and marine areas

Cost benefit analysis of restoration

Many restoration projects have significant benefits in terms of arresting loss of biodiversity or increasing it. In order to justify such investments, benefits are compared against costs so that only those with a sufficient positive gain in net benefits are financed and implemented. This requires benefits to be valued in monetary terms as much as possible. The data in the SESA-EA provides the baselines for such valuations, given the spatial details it contains. The value of current and projected ecosystem services for a given site are provided by the accounts. Investments increase these values in ways that have to be estimated, using similar tools to those deployed to obtain the baseline valuations. The following are examples, where biodiversity gains when taken into account are an important part of the assessment.

Habitat banking and Biodiversity Offsets

While cost benefit analysis is an important tool in allocating resources for conservation and protection it needs to be complemented by others that mandate the protection of key natural assets. For example, the GBF has the target of not causing a loss of biodiversity when making land use changes, particularly in urban and densely populated areas (Target 12). For this purpose, developers might follow the “mitigation hierarchy” regarding any impacts on environment of: avoid, then minimize, then restore impacted areas and finally compensate any impacts that remain (Nature Finance, 2023).

In order to facilitate that last stage, habitat banks have been developed, which allow developers to offset any impacts by “buying” an equivalent habitat, which is preserved in lieu of what is lost. Such

banks have been extensively used in the US and Europe for wetlands and other high value habitats (Barbier and Markandya, 2012). Their use in emerging economies is more limited, although there are recent introductions. Colombia has established some in public and private areas managed for their significant environmental values and work under a performance-based payment. They offer credits to those entities under regulatory compliance but also sell credits to individuals or companies on a voluntary basis. Revenue generated from the sales goes back to pay for management activities. (Nature Finance 2023). The use of credits is discussed further in the section on mobilizing finance.

As Ducros and Steele (2022) note, biodiversity offsets can be useful at a local level, where equivalency error can be minimised and the approach applied to maintain and restore biodiversity. This is not always the case, however, and offsets have been criticized for this reason. A group of developers, with assistance from UNDP and Nature Finance, are currently working on a set of guidelines to define when the use of biodiversity offsets is appropriate. Clearly, central to their work will be constructing indicators that represent the ecosystem condition in terms of its biodiversity in ways that can be compared across sites. The SEEA-EA provides some key information for that.

3.3 Use of economic instruments and fiscal incentives at the micro level

Measures that incentivize changes in behavior to reduce loss of biodiversity are an important part of the portfolio of policies. They will play a key role in helping meet targets 7 and 10 (See Table 1) as well as target 18 (reduce harmful subsidies). The policies include taxes or penalties on activities that cause damage, subsidies for reducing such damage and the creation of markets for biodiversity “services”. These instruments are important because they are often more cost efficient in attaining the objectives than direct regulations and can place a lower fiscal burden on the state.

Taxes and Subsidies

In the case of taxes, the costs of achieving the desired environmental outcomes are borne by those responsible for creating the environmental burdens as stated in the polluter pays principle (PPP: OECD, 1975). In the context of incentives for conservation and biodiversity protection, however, their use has been limited, especially in developing countries. The main reason is that much of the damage done to biodiversity comes from agriculture and food systems more widely. The hidden costs of food systems to the environment are huge: they are estimated to be in the region of US\$3 trillion covering GHG emissions, land degradation, biodiversity loss including loss of pollinators (FOLU, 219; Lord et al, 2023). Of these, costs linked to biodiversity loss, including loss of pollinators and overfishing amount to US\$539 billion (FOLU, 2019). To address through taxes would impose a cost on farmers and raise the price of food, both of which have unfavourable distributional implications.

Payment for Environmental Services

An important set of measures that puts the cost of reducing the environmental cost of agri-food and other land-based activities on the beneficiaries rather than the polluters is payments for environmental services (PES). In contrast to the PPP, the idea is that the beneficiary pays the parties whose activities are damaging the environment to modify their behaviour. A simple example would be a river basin, where the downstream area is highly urbanized and relatively wealthy and the upstream area is rural and relatively poor. Farming practices upstream damage the source of water supply downstream and both parties can gain if the upstream farmers are paid to adopt less polluting agricultural methods. This is referred to as the Beneficiary Pays Principle (BPP).

PES schemes relevant to agrifood systems include biodiversity conservation. Surveys of those that have been implemented indicate that while they can work successfully, difficulties arise when schemes are driven more by government aims and objectives and less by local needs (Pagiola et al.,

2004). There are also issues with adverse self-selection, inadequate administrative targeting, and ill-enforced conditionality. In such cases, payments often do not guarantee environmental improvements despite large outlays. This can be avoided by making sure that schemes are based on the full participation of all relevant parties and proper account is taken of how providers will respond to the incentives offered. Policies such as spatial targeting to service density, threat and cost levels, and payment differentiation can alleviate the design challenges. PES site selection also needs to further move into high-threat areas (Wunder et al. 2020).

There has been a significant rise in the number of PES programmes in recent years, under which payments are made for the purpose of undertaking land/ecosystem management practices intended to ensure the delivery of ecosystem services.

One of the most well-known PES schemes is the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) programme, which incentivizes developing countries to contribute to climate change mitigation actions through conservation and sustainable management of forests. REDD+ is discussed further in the section on mobilizing finance. It is only one of many programmes that address carbon and biodiversity (United Nations, 2020). According to a recent estimate, there are over 550 active programmes around the globe which comprise roughly USD 36-42 billion in annual transactions (Salzman et al., 2018). However, the effectiveness of many of these PES schemes is uncertain: A lack of sufficient data has been identified as one reason for the lack of rigorous PES scheme evaluations, which are needed to ensure effectiveness (Karousakis, 2018). Thus, in order to create informed PES schemes and carry out more thorough evaluations, governments and others need greater access to rigorous and systematically collected data on ecosystems and the provision of ecosystem services. Natural capital accounts are a key source of data that could improve the evidence base upon which PES are designed and evaluated.

Repurposing Agricultural and Other Subsidies

A set of policies that combines PPP and BPP is the repurposing of agricultural and other environmentally harmful subsidies. The removal of some output-based subsidies for production that is environmentally harmful might be seen as a move towards the PPP, while the introduction of a new environmentally friendly subsidy could be considered an application of the BPP.

A recent World Resources Institute report notes, current agricultural subsidies are provided in a way that often rewards unsustainable land use and production. Globally, governments spent more than USD 708 billion (USD 619 billion in net transfers) a year on agricultural subsidies from 2017 to 2019. However, the costs of deforestation and land degradation could be nine times that, at USD6.3 trillion a year, in terms of lost ecosystem services. These include, but are not limited to, agricultural productivity, the provision of clean air and freshwater, and the regulation of the climate. (Ding et al. 2021).

The WRI report shows that restoration practices can improve soil health and lead to a global average increase in crop yields of 2 percent by 2050 compared with a baseline scenario, with a significant rise in agricultural productivity. Thus, by shifting underperforming agricultural subsidies to protecting and restoring degraded farmland, governments can better support local communities and help achieve their countries' climate, biodiversity and rural development goals.

Similar results were obtained at the global level from a policy of shifting subsidies in the World Bank Economic Case for Nature study (World Bank, 2021a) cited earlier (see Figure 4) and have been underscored even further by another Bank report that notes the low return to public support for

farmers (for every dollar spent the return to farmers is just 35 cents) (World Bank, 2022). It finds that measures to repurpose a part of current domestic support as incentives to develop and adopt green innovations that reduce both emissions and costs could potentially deliver substantial gains. Investments in innovations (including research and development) designed to lower emissions and raise productivity by 30 percent could reduce emissions from agriculture and land use by more than 40 percent, returning 105 million hectares of agricultural land to natural habitats, while delivering substantial gains in poverty reduction, nutrition, and the overall economy.

While much of the focus of the discussion of subsidies has been on the agricultural sector, there is in fact a wider range of environmentally harmful subsidies that could be reformed. These include large amounts of fossil-fuel subsidies and fisheries subsidies. A World Bank report from last year (Damania et al., 2023) notes that fishery subsidies in particular are a key driver of excess fishing capacity, dwindling fish stocks, and lower fishing rents. Repurposing subsidies without incentivizing increased fishing capacity is of paramount importance to safeguarding remaining stocks. However, while fisheries remain open-access regimes, repurposing subsidies may have little impact. As much of the overfishing by subsidized fleets occurs in the open seas (a global public good) or in exclusive economic zones in low- and middle-income countries, subsidy reform needs to be coupled with reforms to access regimes. It concludes that well-targeted reforms can lead to triple wins, where ecosystem sustainability improves, fishing fleets of all sizes increase their catches and revenues, and the fishery sector becomes distributionally more progressive.

To apply such analyses requires detailed spatial data on ecosystem condition and land use, of the kind gathered as part of the SEEA EA. Furthermore, it needs to be combined with micro data on households and farmers so policy-makers can determine to what extent the costs of such policies fall on current polluters (who lose their subsidies) or on beneficiaries (those who benefit from the gains in biodiversity, rural development and on). Some case studies in the WRI study suggest that the repurposing can be designed in a such way as to avoid losses to small landholders.

Creating Markets for Biodiversity

The benefits of biodiversity are largely a public good so it is not straightforward to create a private demand for them. Nevertheless, businesses are becoming interested in investing in biodiversity conservation, thus creating a demand for it. One of the current key challenges for companies is how to measure biodiversity performance, as biodiversity is difficult to capture in one simple metric. However, a number of biodiversity measurement approaches for businesses or financial institutions are available or currently in development. These depend to a considerable extent of measuring biodiversity gains and losses, using data from the NCA. These are discussed further in Section 4 on Mobilizing Finance for Biodiversity.

3.4 Tools for Policy Assessment Involving Ecosystem Services

A number of platforms have been developed to combine data on ecosystem extent and condition with biophysical modelling to estimate the change in services provided by a given ecosystem following a change in the levels and patterns of demand for natural resources as a result of implementing a new policy (United Nations, 2021a)⁶. One of the most widely used for evaluating policy options, including investment in Protected Areas (PAs) is **InVEST** (Integrated Valuation of Ecosystem Services and Trade-offs). The software often employs a production function approach to quantify and value ecosystem services. A production function specifies the output of ecosystem services provided by the environment given its condition and processes. Once the production function is specified, the model

⁶ For a more comprehensive list of tools see also <https://seea.un.org/content/supplemental-materials-and-tables-guidelines-biophysical-modelling>. There is also the Integrated Biodiversity Assessment Tool (IBAT), it is used for monitoring several of the GBF indicators: <https://ibat-alliance.org/>.

can quantify the impact of changes on land or in the water or changes on the level of ecosystem service output⁷ (McKenzie et al., 2012). The sub-models available measure changes in several ecosystem services including: carbon storage and sequestration, blue carbon, coastal vulnerability, crop pollination, habitat quality, habitat risk assessment, water purification, sediment regulation, recreation and several others. The habitat quality sub-module gives information most relevant to biodiversity changes and has used Mean Species Abundance as one indicator (linked to the GLOBIO model – see above). Finally, several sub-modules (but not all) contain a valuation component, which places monetary values on the changes in ecosystem services. InVEST is now widely used in cost benefit analysis of investments in conservation as well as in evaluating economy-wide policies.

Another platform that is being used is ARIES (ARTificial Intelligence for Ecosystem Services). It aims to enhance accessibility of ecosystem service models by (1) providing easy access to data and models through a web-based explorer and (2) using Artificial Intelligence to simplify model selection, promoting transparent reuse of data and models in accordance with the FAIR principles (Findable, Accessible, Interoperable and Reusable). ARIES provides a suite of readily available ecosystem services models that can be run at a global or local scale including carbon storage, crop pollination, flood regulation, outdoor recreation, and sediment regulation. Two of these models produce biophysical values (sediment regulation and carbon storage) while the remaining others have been translated into physical and monetary values that are compatible with SEEA EA using national statistics in an application of SEEA EA accounts for Italy. While ARIES provides ecosystem services models, its main aim is to provide an integrated modelling platform where researchers from across the globe can add their own data and models to web-based repositories, where consistent naming and reuse rules enables their interoperability and reusability.

3.5 Economic incentives and strategic choices at the economy-wide and sectoral level

Strategies to promote a shift away from natural-resource intensive dependence and promote asset diversification

In addition to the range of policies considered, governments also need to make strategic choices for their development paths so that they reflect the biodiversity objectives. A key aspect here will be to reduce pressure for expanding agriculture and forest sectors to boost exports, output and income. Often this brings marginal land into production and causes further declines in biodiversity. Thus, rather than relying on export of primary products (even with vertical integration) for growth, countries should follow a strategy that focuses on diversifying the underlying wealth—the portfolio of assets used by an economy, including human capital and renewable natural capital, along with underground assets and produced capital (Pesko et al., 2020). The role of such asset diversification for the biodiversity targets of the GBF would mean a shift away from land and marine intensive natural resource asset exploitation towards other forms of capital, such as solar and wind, as well as non-fossil fuel minerals.

Global Policy Assessments: The Economic Case for Nature

The World Bank study on the Economic Case for Nature referred to earlier was a study in which a global policy shift away from output-based subsidies for agriculture was considered (Policy P1 in the paper) with the aim of making the economy less dependent on agricultural land as an asset. The results by 2030 were summarized in Figure 4: there is an 8% reduction in land conversion and an increase in GDP relative to BAU of US\$57 billion. Thus, there is a gain both in biodiversity and economic growth. Economic activities are less agriculture-based, with a shift to manufacturing and services. Another policy (Policy 2 in the paper) that has an even greater effect on avoided land conversion is payment to landowners to protect forests as carbon sinks. If this is done through a

⁷ [InVEST | The Natural Capital Project \(stanford.edu\)](#).

domestic carbon payment scheme the avoided land conversion is 26% (although the gain in GDP is slightly smaller at US\$50 billion). The results are available at country level so each country can see the impacts of the policies and where the changes in land use are expected.

The modelling involved linking a CGE economy-wide model with a suite of spatial models as part of the Global Futures project. At the core of the approach is the GTAP model – the common language used by the world’s governments to conduct analysis of policy issues such as trade, climate, energy, agriculture, food and water – which is linked to a high-resolution global ecosystem service model, InVEST. The GTAP model is run first to obtain projected outputs under the BAU scenario which, combined with a land use allocation model (SEALS) determines land use consistent with the BAU scenario at a spatially highly disaggregated level across each zone. This land use data is combined with the InVEST model, which estimates ecosystem services for the pattern of land use. It is also combined with a marine fisheries model, which determines the impacts of demand for fisheries on marine ecosystems. Thus, the ecosystem modelling is highly dependent on InVEST, which in turn requires information on extent and condition of ecosystems at the spatial detail that the SEEA EA provides.

Policy Assessments at the Country Level: Peatland Conversion in Indonesia

The above policy assessment was carried out at a global level. Similar models have also been constructed and applied at the country level. An example is a study for Indonesia that analyzes the effects of restrictions on peatland conversion in the country. Indonesia’s development has largely relied on its rich endowment of natural capital, both nonrenewable and renewable resources, including conversion of peatland for palm oil production. The peatlands are low-lying areas of Sumatra, Kalimantan and Papua, characterized by regularly flooded soils with a high percentage of accumulated, partially decayed organic matter. They provide key ecosystem services such as fire and flood risk reduction, biodiversity protection and carbon storage (World Bank 2021b). There are about 15 Mn hectares left, of which more than a third (some 5.5 million hectares), are at risk of being converted to agricultural production, potentially leading to more environmental damage.

The economy-wide model analyzed the key trade-offs involved in managing peatlands, namely developing them for short term growth and jobs, versus protecting and restoring them to preserve the ecosystem services they provide, safeguard human health and well-being and ultimately achieve more lasting job and income growth. The policy options considered were: (a) adoption of a moratorium on peatland conversion that is being planned but that has many loopholes, (b) a program of peatland restoration of 3 Mn hectares, (c) a fully enforced moratorium, (d) a peat tax on production taking place in peatland, (e) a subsidy to landowners not to use peatland for productive purposes and (f) carbon emission reductions resulting from the application of the tax or the subsidy to be traded in international carbon markets, with the proceeds used to finance restoration activities, to offset in part or in full the effect of a tax; or to co-finance the payment of subsidies. The integrated economic-environmental modelling, which links the CGE model to the ecosystem services model through a bridge matrix, is used to estimate the net benefits of each policy in benefit cost terms. This bridge matrix draws on work done as part of the Banks WAVES project to estimate the loss of flood and fire protection resulting from a change in the extent and condition of peatland areas – data similar to the SEEA EA accounts. It turns out that the restoration option has the highest benefit to cost ratio but the economic incentives (d), (e) and (f) also have benefit cost ratios greater than one. The biodiversity benefits come from the avoided fires and floods under the policies that restore peatland or prevent further loss. The eventual choice will need to take account of distribution effects and fiscal considerations but the modelling provides clearly important information.

Potential Strategic Choices for Shifting Away from Natural Resource Intensive Development

Other asset diversification strategies that have not been analyzed fully in integrated economic-environmental economy-wide models include increasing value added from mineral extraction, particularly in Africa and substituting the use of wood for energy with modern energy sources, especially renewable ones such as wind and solar.

On the mineral side, Africa has access to significant mineral resources that are key to the transition to a net zero carbon future. More than half of African countries have at least one of the critical metals needed for the energy transition. The Democratic Republic of Congo (DRC) is at the heart of the dynamic battery value chain as it is endowed with strategic minerals that are components of lithium-ion batteries. The DRC accounts for 70% of the world's cobalt production and over 51% of global reserves.⁸ According to the United States Geological Survey (USGS) data on global mineral reserves, Africa hosts: Cobalt (52.4%), Bauxite (24.7%); Graphite (21.2%), Manganese (46%) and Vanadium (16%).

The main challenge is that Africa still participates only in the small value components of the total value chain. It is estimated to account for only about 10% of the total value leaving other countries where raw materials are exported as the primary beneficiaries. Findings from recent studies by the African Development Bank indicate that deepening Africa's critical minerals value chain calls for some changes in infrastructure improvements, need to stimulate exploration investments, to avail of reliable, clean, and affordable electricity, among others (AfDB 2023). Promoting such developments can help shift the pressure away from expanding marginal land for agriculture as a source of growth and employment. The analysis of such policies can be carried out using the kind of economy-wide models discussed here.

There is also potential to exploit Africa other natural resources such as solar and wind to promote growth in a way that does not harm biodiversity. Africa is by far and away the world's richest region for cheap renewable energy potential, with approaching half (44.8 percent) of the total global technical potential of renewable energy (AfDB 2022). Given its abundant solar and wind potential continent has the world's best potential to produce cheap hydrogen. It is, however, failing to grab this opportunity. So far, clean hydrogen projects and investments have grown quickly, but almost all outside Africa, despite its competitive advantage.

Regarding the use of fuelwood for energy, although that is not the most important cause of deforestation and associated loss of biodiversity it plays an important part in a number of hot spots, especially in South Asia and East Africa (Bailis et al., 2015). Concerted action to reduce the demand for fuel wood through subsidized supply of LPG and renewable sources would generate benefits for biodiversity as well as increasing productivity and wellbeing through reduced health effects. An analysis of such programs using detailed GIS data from the NCA would provide important advice on their net benefits.

4. Mobilizing Finance and Selecting Policies for Realizing the GBF Targets: Roles of the Private and Public Sectors and International Finance Institutions

Target 19 of the GBF states that US\$200 billion has to be raised by 2030 to finance the other biodiversity goals. So far, the amounts available are much smaller: a recent UNEP report on the

⁸ USGS 2021. Mineral Commodity Summaries.

State of Finance for Nature assessed total financial flows to Nature-based Solutions (NbS) were about US\$154 billion annually, of which US\$26 billion or 17% was from private finance (UNEP, 2022). However, not all this is for programs linked to biodiversity. An OECD report estimated finance for biodiversity from all sources (private and public) currently at US\$77-87 billion a year (OECD, 2020). Official finance from donor sources is given from DAC database in the OECD at US\$17.1 billion in 2020 (an increase of 119% since 2011⁹).

Overall, therefore an increase is needed from both public and private sources to achieve this target. The Target goes further in asking for a larger role for private sector finance: Target 19c of the GBF specifically relates to increased private sector finance to support biodiversity, and target 19d calls for schemes such as payment for ecosystem services, green bonds, biodiversity offsets and credits, and benefit-sharing mechanisms, with environmental and social safeguards. Thus, there is a role of both public and private sources of finance. Both have links to natural capital.

4.1 Biodiversity Credits

Biodiversity offsets and habitat banks were discussed earlier: their use so far has been mainly in OECD countries, where a developer who causes a loss of biodiversity in one place can acquire an equivalent amount elsewhere to ensure that there is no net loss as a result of the development. The only example outside the OECD is for Colombia. Some work to develop these further is ongoing and is linked to the creation of biodiversity credits more widely.

Biodiversity credits offer an opportunity for a voluntary purchase of a credit that ensure the protection of a parcel of land with a certain level of biodiversity, or that guarantees an increase in its biodiversity level over time through restoration. The demand for such credits comes from companies with commitments on corporate responsibility (CSR) and those committing to nature-related disclosures (such as under the emerging Taskforce on Nature-related Financial Disclosures (TNFD) Framework¹), philanthropists and impact investors, and individuals interested in conservation. As with voluntary carbon markets, buyers will often be driven by corporate commitments to nature-positive targets (Ducros and Steele, 2022). The supply of credits can be from local communities, NGOs or private companies undertaking to conserve or restore particular areas.

A key factor in getting a market for such credits to work is to have a workable biodiversity metric, so that it can be traded. Once the units for transaction are defined, accounting systems can be set up to establish an inventory and a register and a data management system that supports transparency. The schemes also have to ensure that they genuinely provide additionality (i.e., there is an increase in biodiversity relative to a baseline) and that there is no leakage (conservation at the site does not directly cause an increase in loss elsewhere). Both these depend on being able to establish and monitor a baseline for the sites considered.

The three schemes currently in operation use different metrics so trading across them is not possible. The metrics combine different indicators of biodiversity (ones used include: species richness, importance of species, fauna and flora intactness, IUCN risk category of the ecosystem and ecological connectivity). Account is also taken to how long the preservation is for (permanence) and other factors. All schemes require data on the ecosystem extent and condition so draw on SEEA EA account information where available (but need to go further in some cases). The programs have some promise, they are still in their infancy. As the report from Nature Finance notes, while biodiversity offset schemes are currently mobilising jointly about US\$ 6-9 billion annually, the voluntary side (credits aimed at achieving impacts beyond value chain and targeting higher-order

⁹ [A Decade of Development Finance for Biodiversity | OECD iLibrary \(oecd-ilibrary.org\)](https://oecd-ilibrary.org/publications/a-decade-of-development-finance-for-biodiversity_9b8b8b8b)

contributions) currently has very little trading and associated investment in biodiversity outcomes. One estimate suggests as little as US\$8 million in funding pledged although broader assessment suggest somewhat larger numbers. There is also some debate on the suitability of these credits as effective means of biodiversity conservation.

For the credits to become increase in scale, the metrics have to be applicable at scale so more suppliers can participate. One scheme likely to offer that is the Wallacea Trust methodology, which bases its biocredit on a basket of a minimum of five biodiversity metrics that reflect conservation objectives for the region of the submitted site. Complete taxa (normally functional taxa such as breeding birds or soil invertebrates) are used for each of the metrics and these combine both species richness weighted by the importance value of each species on a five-point scale (e.g., IUCN-listed critically endangered species score a five, IUCN least concern species score one, etc) and abundance on a five-point logarithmic scale. The biocredit is defined as a 1% restoration or avoided loss per hectare in the median value of the basket of metrics. This approach allows biodiversity improvements or avoided loss to be quantified and compared across different ecoregions. Such comparison creates the benefit of collective aggregation of biodiversity stocks in a variety of ecosystems and allows buyers to quantify the impact of their investment in biodiversity improvements and/or avoided loss (Ducross and Steele, 2022).

4.2 Linking Biodiversity to Carbon Credits

Biodiversity-positive carbon credits are carbon credits that include additional and specific management actions linked to the enhancement, conservation, and or restoration of biodiversity. These credit types combine, “link”, or “bundle” verified biodiversity benefits typically in conjunction with a one-to-one carbon credit. In the voluntary carbon market (VCM), biodiversity is often referred to as one in a series of co-benefits that can be bundled or labeled alongside carbon credits - another co-benefit that is often seen as critical for the integrity of such bundled credits is community benefits, meaning the amount of money or material impact that the implementing community receives due to the project. As a result of these additional nature benefits, the credits can be sold at a premium thus providing some finance for biodiversity protection. Not all carbon credits have biodiversity benefits and some (e.g., fast growing monoculture plantations may be good for carbon sequestration, but are typically bad for biodiversity), so only a part of the VCM (currently with a market valuation approaching US\$2 billion) is relevant (GEF, 2023).

The primary overlap between carbon offset markets and natural forest conservation is at the frontier between an expanding agricultural frontier where forests are “next in line” to be felled for that expansion. Typically, carbon credits that are bundled with biodiversity can be traded at a premium relative to stand alone carbon credits. According to Ecosystem Marketplace’s market insights report, credits combined with additional benefits beyond carbon saw a clear price premium over the global 2021 Ecosystem Marketplace’s Global Carbon Price benchmark of \$4.00/tCO₂e; similarly, over the past year the Climate, Community, & Biodiversity (CCB) standard credits added on average about \$2.55 (max \$5.34 / min \$0.54) to the REDD+ and Nature Restoration credit types¹⁰. In 2020, Verra’s CCB standard credits demonstrated a 277% increase in volume sold between 2020 and 2021 representing 17.4 MtCO₂e to 65.9 MtCO₂e in credits (GEF, 2023).

Despite the growth in biodiversity-linked carbon credits, the supply of such credits remains small. To increase the market for such credits will require further use of NCA to standardize biodiversity

¹⁰ The Climate, Community and Biodiversity (CCB) Standards are an additional certification created by the CCB Alliance that can be linked to carbon credits. To receive the CCB label, projects must meet seventeen required criteria. The standards require net positive biodiversity outcomes measured against an established baseline within the project boundaries and project lifetime. The standards require the use of appropriate methodologies for measuring and monitoring but do not prescribe specific methodologies.

measures and adopt a common methodology for measuring biodiversity outcomes. This will help reduce the additional costs and resources necessary to pursue additional certification for carbon project developers seeking biodiversity-positive carbon credit labels.

4.3 REDD+

In addition to this form of credit, there is also the REDD+ framework to bundle carbon reductions, human wellbeing and nature enhancement. Around 50 countries have REDD+ programs at various development phases, and over 350 REDD+ projects have been initiated to Date. Project-based REDD+ credits are supplied both to the voluntary carbon market (VCM) and to compliance markets. They have mainly been linked to the VCM and represent the largest volume of nature-based credits, making up 24.5% of credits issued¹¹. While REDD+ has been active for more than a decade and has played a notable part in preventing deforestation, it has had several problems. These include: “lack of initial financial resources for supplier countries, capacity building for implementation, issues around additionality, leakage and permanence, inappropriate outreach strategies and engagement of IPLCs, climate credibility, governance, lack of cross-sectoral planning and implementation, unclear or missing benefit sharing mechanisms, weak safeguards around information systems. One of the more persistent issues is around the actual and perceived integrity of the credits.” (GEF, 2023, P. 32). To address these, new approaches for the implementation of REDD+ have emerged, referred to as jurisdictional and nested approaches. Jurisdictional REDD+ approaches are a departure from project-based REDD+ initiatives in that they operate at the national or subnational levels and are rooted in more expansive and inclusive governance systems than what can be achieved through the scope of an individual project. Similarly, nested approaches seek to integrate standalone projects at multiple scales into a single accounting framework that uses data from the SEEA EEA. On use of such data for REDD+ in a nested approach see World Bank (2021c).

4.4 Public Sources of Finance

Along with market-based sources of finance, there are a number of financial instruments that involve direct public sector investment in specific instruments. They aim to establish proof of concept or a commercial track record of new solutions, which can become either replicable or scalable. Grants remain the most frequent financial instrument for biodiversity to date, but their concessional nature and limited long-term sustainability come at high cost for public institutions. This has led to a search for more innovative instruments that blend public and private finance (“blended finance”), helping leverage private financial flows at scale and increase the efficiency of scarce public resources.

Sovereign debt is one such instrument. Debt conversions, often known as “debt for-climate” and “debt-for-nature swaps” are transactions where countries restructure, reprofile, and reduce their debt obligations in exchange for committing some portion of the freed-up financing toward domestic climate and nature projects (IMF, 2022). Debt for climate and nature swaps rely on blended finance, in the form of insurance policies or guarantees to provide below market borrowing rates for the borrower country. Examples include the GEF-supported Seychelles’ 2016 debt conversion, which resulted in \$ 22 million of investment in marine conservation (Convergence, 2017). Belize’s 2021 debt conversion enabled the issuance of \$ 364 million worth of blue bonds linked to national marine conservation activities (TNC, 2022). A modified financial structure using partial guarantees provided by IDB and TNC was used to refinance \$150M in Barbados’ debt to support implementation of their marine conservation 30x30 commitments in 2022 (GEF, 2023). Recently, Portugal agreed to provide debt relief to Cabo Verde on condition the funds are used for climate and nature (Expresso Das Ilhas, 2023).

¹¹ [Voluntary Registry Offsets Database, Berkeley Carbon Trading Project](#)

4.5 Public-Private Blended Sources of Finance

Instruments involving public and some private sources can also support nature and climate objectives. One of these is Green, Social, Sustainability and Sustainability-linked (GSSS) bonds, which represent a new asset class across developed markets. GSSS bonds, which grew by \$600 billion in 2021 alone, are borrowing instruments where the financial and structured characteristics are based on meeting pre-agreed sustainability criteria measured through key performance indicators (KPIs) (GEF, 2023). For example, nature performance bonds are tied to measurable targets for restoring wetlands, protecting forests, and reducing threats to wildlife and plant species, while still allowing for general use of proceeds (Nature Finance, 2021).

Countries can issue these bonds when seeking to raise cheaper financing for any purpose, while simultaneously pursuing their own national sustainability goals. While this type of bond is nascent and limited to countries with economies strong enough to raise funds in capital markets, there are increasing examples of such issuances. Chile issued a \$2 billion sustainability-linked bond in March 2022, with two KPIs geared towards reducing emissions and increasing Chile's use of renewable energy (BNP Paribas, 2022). Benin issued a EUR 500 million sustainable development goal (SDG) bond in July 2021. The bond is linked to Benin's framework and based on the prioritization of the most pressing targets and on the total cost to achieve them (Natixis, 2021a). Mexico issued a EUR 750 million SDG bond in September 2020, and a second EUR 1,250 million SDG bond in July 2021, linked to Mexico's commitments under the 2030 Agenda and SDG commitments (Natixis, 2020; Natixis, 2021b).

On biodiversity specifically, one landmark example is the Wildlife Conservation Bond or "rhino bond", issued in March 2022 by the World Bank with GEF support. This five-year \$150 million Sustainable Development Bond is a combination of existing financial products – a bond with an excellent credit rating paired with a performance-based grant funded by the GEF, which results in a ground-breaking financial structure that enables private sector investment in global public goods. At the end of the life of the bond, investors will receive back the principal along with a variable pay out depending on the population growth rate of black rhino, a critically endangered species, in two target areas in South Africa. The coupon payments from the bond, instead of going to investors as for typical bonds, are instead used to fund the conservation activities on the ground. (GEF, 2023)

While having considerable potential, GSSS bonds still make up just a fraction of the bond market. The size of this market remains particularly limited in developing countries: Africa, for instance, accounted for only 0.077% of the global green bond market in 2021. (GEF, 2023). The market for GSSS bonds is hampered by several barriers in developing countries, especially least developed countries and small island developing States. Adequate market infrastructure is needed to provide the foundation for capital market depth and liquidity. This includes exchanges and trading platforms, clearing houses, credit risk assessment, custodians, and fiduciaries, without which bond markets will be difficult to scale. To address these barriers, the Global Climate Fund (GCF) has invested in multiple solutions, including the above-mentioned Green Guarantee Company and support to Jamaica in setting up a Caribbean green bond listing on the Jamaica Stock Exchange, enabling it to list green bonds through a dedicated facility.

Equity is another instrument that can be found under the "blended finance" label. The above-mentioned Global Fund for Coral Reefs, for instance, uses GCF's \$125 million in public first-loss equity to crowd in private equity, with the potential to create a new asset class to mobilize institutional and citizen savings for coral reef protection.

5. Conclusions

Biodiversity is a key component for the integrity and functioning of terrestrial and marine ecosystems, which in turn provide critical services to the economy and society that are embedded in nature. Both biodiversity and ecosystem services have been declining in many countries and within global commons, resulting in losses that affect the wellbeing of many, especially those most dependent on these assets. The resource dependent communities, including women and poor people in low-income countries are particularly vulnerable and disproportionately affected by the loss of biodiversity and ecosystem services.

The major direct drivers of the losses are industrial fishing, intensive agriculture, especially overgrazing, loss of forest cover, over-harvesting of wild plants and animals and extractive industries. The indirect factors behind these are increase in population, loss of indigenous knowledge for managing nature, migration and urbanisation and expanding trade, which does not account for the externalities from the export of land- and marine-intensive products. Underlying these drivers is the way economic activities are organized and supported by governments and private decision makers that lead to under-pricing of natural capital or negative impacts that impose high social costs that are not captured into national system of accounts or firms' balance sheets. For example, agricultural, fishery and energy subsidies exert increased pressure on ecosystems. The fact that many of these systems are part of global commons but are controlled by national jurisdictions or not controlled at all means they tend to be over-exploited. The failure to reflect externalities associated with many nature-based activities in the prices paid for the final products accelerates over-exploitation of nature.

The losses of biodiversity and degradation of ecosystems matter because they impact on the ecosystem services that provide benefits to people in the short-term and diminish opportunities for long-term growth and sustainable development in affected countries. Declines in services include: pollination; soil quality; flood and erosion control; disease control; regulation of freshwater flow and quality in watersheds and wetlands; regulation of air quality, climate and ocean acidification, and regulation of extreme events among others. When certain thresholds are exceeded, loss of biodiversity and ecosystem services could drive large responses and feedbacks that severely disrupt provision of benefits to people and economies.

To facilitate mainstreaming of nature and biodiversity into economic systems, these contributions of nature can be quantified in monetary terms through the concept of renewable natural capital. Natural capital accounting is often used to measure in monetary terms the goods and services that nature provides to economies (e.g., the changing wealth of nations report produced by the World Bank). Estimates of such capital indicate that in *per capita* terms it has declined in low-income countries during the past quarter century. Furthermore, "blue natural capital" (fishery and mangroves) has declined globally by half over the same period, mainly because of a collapse in the value of fishery,

While past and present policies have resulted in significant losses of natural capital, recent studies have shown that an ambitious program, with the right policies, can avoid further losses and recover some of the past losses. The targets for such a program are set out by the Kunming-Montreal Global Biodiversity Framework (GBF), an outcome of the 2022 United Nations Biodiversity Conference. Furthermore, a major role in selecting the right policies and implementing them effectively in the right places to meet the targets of the GBF often depends on availability of data using the UN System of Environmental Economic Accounts – Ecosystem Accounting (SEEA EA) framework. This Natural Capital Accounting System links the information on the extent and condition of different ecosystems to the services they provide and to the values of those services.

The role of NCA is in providing information to undertake an evaluation of policies and investments related to the different targets. Benefits of meeting the GBF targets result in an increase in ecosystem services that can only be measured if data on the baseline services and their dependence on condition are available. These benefits determine priorities of where action should take place to meet the targets and in designing measures that yield the greatest net benefits. Data on ecosystem condition are also important in determining sustainable exploitation rates for renewable resources and in setting regulations on harvesting and trade. In addition, data on biodiversity indicators is the basis for biodiversity credits and other markets, which derive tradable biodiversity 'units' based on these indicators. The ecosystem condition accounts provide important information for this purpose.

A range of policies will have to be implemented to achieve the GBF's 2030 targets. These include regulatory measures, investments in conservation and restoration of degraded land and marine areas, use of economic and fiscal instruments for different sectors of the economy and incentives and strategic choices at the economy-wide and sectoral level. There will also be a need to mobilize more funds to implement these measures.

A review of recent experience in designing and implementing these measures reveals that there is a critical need for data of the kind that the SEEA EA provides. This information helps in the design of the investments and regulations as well as in monitoring and reporting on their implementation.

Potential for the use of economic instruments is highlighted in studies that show the potential for repurposing subsidies for agriculture and fishery as well as designing schemes of payments for ecosystem services that draw on the detailed spatial information in the natural capital accounts to ensure effective targeting of ecosystems at risk and mandating of payments to results. New instruments are also being developed that allow for habitat banking typically on low-yielding lands but with significant potential for conserving biodiversity, which can be made more effective if the data on what is allowed as a substitute for a lost habitat is genuinely equivalent in terms of ecosystem extent and condition. The SEEA EA helps provide that information.

In addition to the sectoral policies considered, governments can also make strategic choices for their development paths so that they reflect the biodiversity objectives. As noted, a significant factor will be to reduce pressure on agriculture and forest sectors to boost exports, output and income. For this, countries could follow a strategy to diversify their portfolio of assets such that it makes a shift away from land and marine intensive natural resource asset exploitation towards other forms of capital, such as solar and wind, as well as non-fossil fuel minerals that generate "green jobs" and sustainable growth. Such asset diversification strategies that have not been analyzed widely could include increasing value added from mineral extraction while limiting impacts on biodiversity (e.g. mining in forested areas), particularly in Africa, and substituting the use of wood in rural areas for energy that contributes to deforestation with modern energy sources, especially renewable ones such as wind and solar.

Finally, there is the need to mobilize finance to implement many components of the programs. The GBF states that US\$200 billion has to be raised by 2030 to finance the other biodiversity goals. So far, the amounts available are much smaller; an OECD report estimated finance for biodiversity from all sources (private and public) currently at US\$77-87 billion a year. Thus, an increase is needed from both public and private sources to achieve this target.

On the private finance side, there are a number of new instruments, such as biodiversity credits, which offer an opportunity for a voluntary purchase of biodiversity protection to companies with commitments on corporate social responsibility (CSR) and/or explicitly considering nature and climate risks into their core investment and business strategies. There are issues relating to the

metrics used and potential for scaling up the existing schemes but some advances are being made (e.g. ESG data supported by the World Bank's Global Program on Sustainability to inform financial market decisions). Some involve linking biodiversity credits to carbon credits. There are also some developments in the REDD+ market that hold promise for expansion using data from the SEEA EA.

Notwithstanding these developments, the current level of the market for biodiversity credits and REDD+ is small. Efforts for developing high integrity biodiversity credits, including measurement, reporting and verification systems will be key to developing such markets. Increased interest among major financial institutions and business towards nature and climate related financial disclosures (e.g., TNFD and TCFD) offers promise for attracting private sector finance for nature and biodiversity.

On the public finance side, a number of financial instruments aim to establish proof of concept or a commercial track record of new solutions, which can become either replicable or scalable. Grants remain the most frequent financial instrument for biodiversity to date but pressure on such sources is high. Others that blend public and private finance ("blended finance"), help leverage private financial flows at scale and increase the efficiency of scarce public resources. These include debt conversions or "debt for-climate" and "debt-for-nature swaps" in which there is renewed interest¹². Such instruments have been tried for some decades with a number of benefits, but also downsides. It has been noted that a debt swap can downgrade a country's debt rating. Furthermore, any deterioration of the fiscal situation in a debt swap country can undermine the capacity of the debtor country to meet its obligations under the DNS (OECD, 2007). Again, amounts raised so far are small.

Instruments involving public and some private sources, such as Green, Social, Sustainability and Sustainability-linked (GSSS) bonds are based on meeting pre-agreed sustainability criteria measured through key performance indicators (KPIs). Examples for issuance of such bonds include Benin, Chile and Mexico. On biodiversity specifically, a landmark example is the Wildlife Conservation Bond or "rhino bond", issued in March 2022 by the World Bank with GEF support. Data and evidence from programs supported by such bonds will help make the case for them and expand their use. So far, while having considerable potential, GSSS bonds make up just a fraction of the bond market and are extremely small in developing countries. Equity is another instrument that can be found under the "blended finance" label.

In conclusion, meeting the biodiversity targets remains a challenge but one for which there is hope if the right policies and programs are implemented. To do this, data and evidence on the impacts of any measures is critical and natural capital accounting has a central part to play in providing it.

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¹² <https://www.imf.org/en/Blogs/Articles/2022/12/14/swapping-debt-for-climate-or-nature-pledges-can-help-fund-resilience#:~:text=Such%20countries%20face%20a%20high,spending%20on%20other%20development%20priorities>.

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