An introduction to funding mechanisms for natural capital

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1. The value of natural capital

Natural capital, or assets, is limited. Capital goods, or more simply "capital", are physical assets companies use to produce goods and services. Capital goods are generally of two types: produced capital and human capital. Produced capital is mostly composed of transferable, or "alienable", assets, such as roads, buildings, machines, ports - tangible -, and patents - intangible. Human capital refers to non-alienable assets - mostly intangible - such as health, education and skills [1]. Aside from these two main types of capital, there exists a third one called natural capital. Natural capital, or natural assets, are the natural resources available in an economy (e.g. [2]). They can be either renewable assets, such as fisheries and forests, or non-renewable assets, like fossil fuels and minerals [1]. Natural capital can be tangible and alienable (plants), tangible and often non-alienable (pollinators), intangible and alienable (the view from one's sea-front home), intangible and non-alienable (global climate) [1]. Natural capital provides services such as energy, water, plant and fiber growth, from which people derive benefits, also called ecosystem services (e.g. [3]). While it is acknowledged that firms use natural capital, for a long time this aspect has not been a matter of concern, as the "usage rate" was lower than the rate at which natural capital was naturally regenerated. However, in the past 30 years this logic has flipped, as we started using more natural capital than what was regenerated.

Biodiversity is an enabling asset for natural capital. It is important to make the difference between capital goods and enabling assets. Enabling assets are public knowledge, institutions and mutual trust that enable capital goods. For example, peace enables education, or taking care of the atmosphere. The accounting price of capital goods largely depends on these enabling assets. Biodiversity, which is the variability among plants and other living organisms, is an enabling asset for natural capital. The value of biodiversity is thus embedded in the accounting prices of items of natural capital, such as ecosystems.

Natural assets are largely undervalued. While economic agents may value natural assets in different ways - depending on what impacts most their economic activity -, the way they manage these assets always boils down to a matter of cost minimization. The problem with natural assets is that there is often no market for such resources, so they usually come for free. Economic agents thus only need to minimize the extraction and harvesting costs for natural resources, but they are not required to pay for the resources themselves (e.g. [3]).

Furthermore, often natural capital is not only free, but can even have a "negative" price because of government's subsidies - such as the subsidies for oil and mining companies. The absent or negative price of natural assets no longer reflects their large social value and leads to a price gap. Specifically, there is a gap between the market price of natural assets, i.e. how much they are valued by economic agents, and their accounting price, i.e. the value they have as a public good for society, mostly coming from their scarcity.

Estimating natural assets' accounting price, i.e. their public value, is difficult. Market prices are often used to approximate accounting prices, though most of the time market prices for natural capital are simply missing. Economists have thus focused on measuring ecosystem services, which are the benefits that we derive from natural capital. These benefits can be measured via questionnaires asking participants to place a value on these benefits (e.g. [4], [5]).[1] Another way to value natural capital is considering the cost it would take to mitigate and restore the amount of natural capital that was lost. For example, the accounting price of a road includes the cost of building ways for animals to cross around the road (mitigation) and, if the road in question damages natural habitats, the cost of recreating these natural habitats elsewhere (restoration). This methodology is used in biodiversity offset programs, which are covered below.

2. Funding mechanisms for natural capital

As investing in natural capital is generally not profitable, regulators have created artificial mechanisms to price natural assets and either preserve or restore them.[2] Here we will refer to "market mechanisms" for natural capital mostly as those systems based on units of natural capital with a related price, given mainly by the interacting demand and supply of such units (trade). Differently, we will use the term "non-market mechanisms" for natural capital to refer to all other mechanisms in which the value of natural capital is not given by a trading system.

Today, there are several mechanisms for valuing natural capital in place. Both the public and the private sector use these systems to channel money towards the preservation and restoration of natural assets. At the moment, the largest resources are allocated towards climate-related objectives (climate finance), with an overall amount of US$579 billion invested annually [6]. Approximately half of it is coming from the public sector (56%) and half from the private sector (44%). When it comes to nature-related objectives (nature finance), the overall amount is much lower, around US$133 billion per year [6]. Furthermore, there is a much larger imbalance between the contributions of the public and private sector, with the latter contributing only to 14% of these funds.[3] In this section we describe the current state of the existing systems to finance the preservation of the atmosphere and nature more in general, highlighting the main advantages and issues of each system.

[1] These benefits can be both direct and indirect, i.e. water filtered by wetlands that is used for breeding of animals.

[2] For example, the Dasgupta Report (2021) mentions the low profitability of preservation and restoration activities, and therefore the lack of a case for private investments to finance them.

[3] Currently, 36 countries are using the UNDP's Global Biodiversity Finance Initiative (BIOFIN) to understand how much of the public budget is being spent on conservation and restoration of biodiversity (UNDP, 2018).

2.1. Existing mechanisms

There are several existing financing mechanisms for natural capital, especially for carbon and biodiversity. We will start with the market mechanisms, and specifically carbon markets, which can be differentiated between compliance and voluntary markets.

2.1.1. Market mechanisms for natural capital

Compliance carbon markets are mechanisms created by governments and multilateral organizations to reduce countries' carbon emissions using carbon allowances, i.e., rights to emit. Each country has an allocated amount of such allowances, which is set in international agreements such as the Kyoto Protocol of 1992 and the Paris Agreement of 2015 [7]. Following these agreements, single countries established compliance carbon markets in the form of cap-and-trade systems, also known as Emission Trading Schemes (ETS). In this overall mechanism, countries allocate rights to emit to companies, which can emit carbon up to a certain threshold ("cap"). Beyond this cap, companies must buy allowances from either companies below the cap or certified carbon-capture projects in emerging economies that issue carbon allowances.[4] Today, ETS are present in 23 countries and cover around 15% of global emissions [8]. One tonne of carbon in the EU ETS market costs around 85-95 Euros [9]. More information on compliance carbon markets are reported in Box 1.

Box 1 – Compliance Carbon Markets

The Kyoto Protocol was one of the first steps towards the creation of an international, compliance carbon market. This Protocol is an international treaty signed in 1997 by 180 parties with the aim of reducing global greenhouse emissions by at least 5% below 1990 levels between 2008 and 2012 [7]. Following the principle of environmental law of "common but differentiated responsibilities and respective capabilities", industrialized countries that committed to the Protocol had an obligation to reduce their emissions according to country-level targets, while developing countries could contribute voluntarily. Targets were then translated into an "initial assigned amount" of allowable emissions that are measured in tonnes of CO2 emission equivalents [10]. These emission allowances can be also referred to as either emission units or emission credits, from which the term "carbon credit".[5] For example, Switzerland was assigned 242,838,402 tonnes of CO2 equivalents for the period 2008-2012 [11], and managed to respect this commitment [12].

The Protocol established three market-based mechanisms to introduce more flexibility on allowable emissions. These mechanisms allowed signatory countries to add to or subtract from their initial assigned amount by trading emission allowances on a global scale [10]. The first mechanism, called Emission Trading, enabled countries that have unused emission allowances - those that have been allotted to them but not utilized - to trade their surplus to countries that have exceeded their emissions targets. The other two mechanisms, the Clean Development Mechanism (CDM) and Joint Implementation, were designed to incentivize developed countries to invest in emission-reducing projects in developing countries and thereafter issue carbon offsets.[6]

[4] More precisely, the Kyoto Protocol established three market-based mechanisms to introduce more flexibility on allowable emissions and allow signatory countries to add to, or subtract from, their initial assigned amount by trading emission allowances on a global scale [23]. The first mechanism, called Emission Trading, enabled countries that have unused emission allowances - those that have been allotted to them but not utilized - to trade their surplus to countries that have exceeded their emissions targets. The other two mechanisms, the Clean Development Mechanism (CDM) and Joint Implementation, were designed to incentivize developed countries to invest in emission-reducing projects in developing countries and thereafter issue carbon offsets. These credits must be certified by official organizations. For example, credits in the CDM are certified by the CDM Executive Board, an institution set up by the United Nations Framework Convention on Climate Change (UNFCCC) [26]. A platform to find the UNFCCC-certified credits is here: https://unfccc.int/climate-action/united-nations-carbon-offset-platform. For other types of units that could be traded under the Kyoto agreement, see here: https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading.

[5] In the Kyoto agreement, they were called Assigned Amount Units (AAUs), or "Kyoto Units".

[6] These credits must be certified by official organizations. For example, credits in the CDM are certified by the CDM Executive Board, an institution set-up by the United Nations Framework Convention on Climate Change (UNFCCC) [13]. A platform to find

Based on this framework, single countries established national or regional compliance carbon markets in the form of cap-and-trade systems, also known as Emission Trading Schemes (ETS). Generally, in a cap-and-trade system, the national regulator sets the total amount of emissions (cap) according to climate protection goals (e.g., the Kyoto Protocol targets).[7]

Emission allowances are then allocated to companies. Allowances can be assigned to companies either for free or through auctions.[8] If a company emits less than what is allowed from the sum of its allocated emission allowances, it can sell these extra allowances to peers that emit more and vice versa, giving birth to a market (trade). As such, companies that can reduce their emissions by one tonne at a lower cost than the price of one allowance, are incentivized to reduce emissions by adopting less polluting technologies and making a profit out of the sale of the allowance (or carbon credit). At the same time, companies that cannot do that can still emit by purchasing allowances (or carbon credits) from the companies below their thresholds [17].

Today Emission Trading Schemes (ETS) are present in 23 countries and cover around 15% of global emissions. Following the emission-reduction commitments for the period 2008-2012 of the Kyoto accords, many countries individually extended their commitments, with new endowments of allowances decided in the Paris Agreement of 2015. Today there are 23 countries with ETS systems in place. Together with other 23 countries that have a carbon tax, these carbon-pricing initiatives cover around 8 gigatons of CO2, which is around 15% of global GHG emissions (UNFCCC Website).

For example, one tonne of carbon in the EU ETS market costs around 85-95 Euros.[9] The price of a unit of CO2, or carbon price, in a country depends on the supply and demand of emission allowances, which in turn depends on how many companies are above and below their caps and how many allowances are available in alternate mechanisms like the Clean Development Mechanism. On December 1st, 2022, the price of one allowance (or carbon credit) in the European Union ETS was 85.22 euros, which was a more than twofold increase compared to the average price in 2021.[10] The value of the transactions occurring in 2021 in those markets is estimated to be around €865 billion [18].

Switzerland has a long tradition of ecological measures and is a proponent of the "polluter pays" principle [19].[11] In 2008, the Swiss government introduced the Emissions Handel System (CH EHS), a cap-and-trade system under the Kyoto Protocol umbrella. The CH EHS together with a carbon tax, and command-and-control policies are part of the CO2 Act, a law that aims at reducing greenhouse gas emissions arising from the combustion of fossil fuels. The CH EHS became compulsory in 2013 for installation operators with high greenhouse gas emissions, including cement, chemicals and pharmaceuticals, refineries, paper, district heating, and steel, while participation for medium size entities remained voluntary.

Firms receive most of their emission allowances for free, while a residual part is auctioned. Since 2021, Switzerland is reducing the cap by an annual factor of 2.2% of the 2010 baseline. The distribution of free allowances across sectors is guided by harmonized allocation rules based on the benchmarks of emissions performances [20]. The number of emission allowances per tonne of product (or terajoule of heat used) defines most of the benchmarks, corresponding

the UNFCCC-certified credits is here: https://unfccc.int/climate-action/united-nations-carbon-offset-platform. These alternative mechanisms traded alternative units, which can be found here: For other types of units that could be traded under the Kyoto agreement, see here: https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading.

[7] Note that the emissions currently included in ETS schemes are direct emissions, and some countries are considering the inclusion of indirect emissions - mainly scope 2 [14].

[8] When allocated for free, there are two main methods: 1) grandfathering, where allocations are based on a company's historical emissions for a given year or period [15], and 2) benchmarking, where allocations are based on the regulator's assessment of the best industry practices and emissions targets [16].

[9] We are referring to tonnes of carbon dioxide equivalent, as per the Glossary of Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_equivalent.

[10] Figures are from Statista, here and here. This increase can be due to a more stringent upcoming regulation and climate goals, and the increase in coal use due to the recent gas shortages (e.g. here).

[11] Article 74 of the Swiss Constitution, titled Protection of the Environment, states that the Confederation shall ensure that damage and nuisance against the environment shall be avoided and that "the costs of prevention and remediation shall be borne by those who have caused them".

to the emissions of a greenhouse gas-efficient production facility. As of 2020, Switzerland and EU member states, under the European Union Emission Trading Scheme (EU ETS) can trade credits via the three mechanisms provided by the Kyoto Protocol.

The case of Holcim. As an example of how Switzerland assigns units to companies, we can consider Holcim, a Swiss company active in the production of materials and one of the largest cement manufacturers in the world. With more than 2.5 million tonnes of cement produced annually from the three plants in Eclépens, Siggenthal and Untervaz, Holcim is also the largest cement producer in Switzerland. These three plants fall under the CH EHS. In 2022, out of the 3,358,572 permits allocated to Swiss installations, 1,207,421 were allocated to the three Holcim's plants (data from the Swiss Emission Trading Registry).[12]

Voluntary carbon markets allow companies to voluntarily reduce their carbon emissions by purchasing carbon offsets. Carbon offsets differ from carbon allowances, or credits, in that they are not used to fulfil emissions requirements set by international and national authorities [21].[13] Furthermore, voluntary markets do not have official regulations, and market standards are set by private certifiers, such as the American Carbon Registry, Verified Carbon Standard (Verra), the Gold Standard Impact Registry, and the Climate Action Reserve. Today, one tonne of carbon in the voluntary carbon market costs around US$3 [22].

Borrowing from these frameworks, practitioners have started developing new funding and market systems for natural capital in general, and biodiversity more specifically [23]. As it is for carbon, also for biodiversity there are compliance and voluntary systems. However, compliance systems are predominant, and include both cap-and-trade and offsetting schemes.

Box 2- Voluntary Carbon Markets

Voluntary carbon markets lack regulations. As voluntary carbon markets have been existing since 1989, long before regulated carbon markets and the Kyoto Protocol were designed, these markets have set their own standards. Before issuing a carbon offset, project developers must enroll their project in so-called registers following specific standards provided by independent third parties. These services are offered by verifiers such as the American Carbon Registry, Verified Carbon Standard (Verra), the Gold Standard Impact Registry, and the Climate Action Reserve. Once issued, carbon offsets can be traded on different platforms.[14] The lack of supervising authorities makes voluntary carbon markets largely unregulated. Theoretically, everyone might develop an offsetting project (e.g., planting trees) and sell it to potential buyers. In practice, non-profit organizations fighting climate change are the most common project developers [21]. As emission reduction certifications might be conducted by either the project developers themselves or third parties, a wide range of accounting methods exists, resulting in a lack of uniformity, transparency, and reliable registration systems [21].

Certifications in the voluntary carbon markets rely on the principles of additionality and permanence. The only seemingly common aspect across certifications - both official like the Clean Development Mechanism mentioned above, and unofficial - is assessing the additionality and permanence of the carbon-sequestration project. Additionality refers to the notion that carbon sequestration would have not occurred under a business-as-usual scenario, while permanence refers to the warranty that such sequestration lasts over time. Even though several studies have been conducted on how to better assess additionality [24] and permanence [25], and new technologies are implemented (e.g., blockchain and satellite imagery), the lack of uniformity among certification standards and entities is still an issue in this industry.

[12] More information on the ETS for installation operators in Switzerland is available here: https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/ets/installations.html.

[13] For example, the Verra credits can be used in compliance carbon markets only in Colombia and South Africa, and within the Carbon Offsetting and Reduction Scheme for International Aviation (Verra).

[14] Examples are the Sylvera Platform, Carbon Trade Exchange and Air Carbon Exchange.

Additionality and permanence distortion

Leading sources of concern in voluntary carbon markets are, among others, the two requirements of additionality and permanence [24], [25]. These two characteristics are particularly relevant for afforestation and reforestation projects [26]. In the case of trees, additionality can be easily misconducted by using existing forests instead of planting new trees, while permanence is at risk due to natural events such as wildfires that might release the carbon stored into the atmosphere [26]. The cost of certifying additionality and permanence can vary significantly between voluntary and compliance markets. For example, in 2007 the cost of verifying a project in voluntary carbon markets ranged from 5,400 US$ to 23,100 US$ per project across different third parties' verifiers, while under the Kyoto Protocol, the CDM Executive Board charged up to 350,000 US$ to approve a carbon offset project [27].

Carbon offsets under scrutiny: the Verra scandal

The quality of carbon offsets has come under scrutiny in a joint investigation by The Guardian newspaper into Verra's certifications of Reduction of Emissions from Deforestation and Forest Degradation (REDD+) projects [28]. The investigation alleges that 90% of all certifications issued by Verra, the world's leading carbon standard agency, do not reflect genuine emission reductions. The certification of REDD+ projects is based on the amount of emissions avoided by preventing deforestation. Thus, the more disastrous the business-as-usual scenario is estimated in terms of deforestation, the higher the avoided emissions will be. According to The Guardian, these projections were overestimated by 400%.

Standard developments and supervising institutions

Even if there is no clear definition of quality, standardization of carbon offsets is having momentum. The European Union is working to develop a system that reliably certifies carbon removal projects [29], and the recently founded Integrity Council for the Voluntary Carbon Market (IC-CVM) is designing a comprehensive guide to carbon offset standards including a set of Core Carbon Principles (CCPs). The objective of this initiative is to establish a labeling system that marks offset projects that meet a given threshold of high quality. Also, carbon rating agencies are arising, such as Calyx Global, Bezero Ratings, and Sylvera, providing a rating system for projects in voluntary carbon markets. Slyvera, for example, compares information provided by project developers with their own measurements using machine learning algorithms and remote sensing data. Finally, similarly to ESG rating agencies, it rates the projects with a letter (e.g., AAA).

Cap-and-trade markets for specific aspects of biodiversity, like fish species, are regulated under the binding system of Individual Transferable Quotas (ITQs), also referred to as biodiversity permits, or allowances. In this system, a regulator sets a limit to the use of a specific natural resource (e.g., fish), which is then divided into allowances, or permits, that are distributed among companies or individuals. These tradable permits represent policy instruments that governments use to prevent biodiversity loss often related to species overexploitation due to fishery or hunting [30]. For instance, one permit corresponds to one tonne of fish. Following the same mechanism as carbon, actors can trade these instruments. There are currently 42 tradable permit schemes in 26 countries, which have been recognized as significant for biodiversity [30].[15]

National schemes for biodiversity offsets aim to limit their impact on biodiversity of new infrastructure projects. There is usually a hierarchy of actions to achieve such a goal, namely avoid possible impacts, mitigate if they cannot be avoided (e.g. minimization or on-site rehabilitation), and lastly offset any residual impact. In this last level, biodiversity-negative companies can either offset their impact themselves or outsourcing the offsetting activity to owners of biodiversity-positive projects, so called bio banks, by purchasing specific credits

[15] These countries are Argentina, Australia, Canada, Chile, Denmark, Estonia, Finland, Iceland, Lithuania, Malta, Mauritius, Mexico, Morocco, Mozambique, Namibia, Norway, New Zealand, Peru, Spain, Sweden, South Africa, the United Kingdom and the United States. For critiques of this system, see [31].

from them, so called bio credits.[16] There are currently around 100 countries with such schemes [32] and there are around 12,983 (mostly small) offset projects in 37 countries [33].[17] For example, in Switzerland the accounting price of building a road includes the cost of building ways for animals to cross around the road (mitigation) and, if the road in question damages natural habitats, the cost of recreating these natural habitats elsewhere [35]. Finally, outside of these compliance programs, the demand for bio credits led to voluntary biodiversity markets, some of which are regulated at the national level.[18]

Switzerland has a long tradition of ecological legislation, starting in 1876 with the Forest Inspectorate Act, which promoted the sustainable management of forests (Dictionnaire historique de la Suisse, 2015). Throughout the years, Switzerland updated its legal framework with additional acts that provide for the conservation and promotion of biodiversity (FOEN, 2017) and embraced a strategic framework to address biodiversity loss in a systematic way. After ratifying the Convention on Biological Diversity in 1995, as the equivalent of the United Nations Framework Convention on Climate Change (UNFCCC) for biodiversity, Switzerland finally submitted its national biodiversity strategy in 2012, called the Swiss Biodiversity Strategy.

When protection and restoration is not possible, equivalent compensation must be put in place, in sites that are in the same area of the biodiversity loss. The Federal Act on the Protection of Nature and Cultural Heritage mandates the "best possible protection, restoration, or, failing that, the provision of appropriate compensation" where "damage by technical interventions to habitats deserving of protection is unavoidable" [36]. Sites where the compensations take place must be in the same area and be equivalent in terms of ecological function [37]. Cantons are in charge to oversee such restoration projects by providing metrics and quality of the offset. However, finding appropriate locations for compensation is becoming more challenging. Additionally, some cantons are lacking the expertise, a qualified workforce, and finances to perform this task.

2.2. Non-market financing systems for natural capital

Non-market systems for pricing natural capital include all systems and tools put in place by both public and private institutions to finance the preservation and restoration of natural capital, that do not have a price-setting mechanism based on trading.

Carbon taxes and funds for negative emissions. As a complement to the mentioned Emission Trading Schemes, 36 countries currently have in place a carbon tax, which is a tax on companies' emissions [38]. For example, Switzerland has a "CO2 levy" of 120 CHF per ton since 2022 [39]. A new proposition to tackle the aspect of negative emissions – removing more CO2 than what is emitted – are polluter-pays sovereign funds that receive money from polluters (via a carbon-tax like system) and invest them into projects for negative emissions [40]. These polluter-pays funds are very much in line with the funding mechanism for natural capital that we will propose in what follows.

[16] Such as the ones used by the California Department of Fish and Wildlife.

[17] As offsetting can give an incentive to companies to degrade the environment, the IUCN stated that offset projects must now provide a net gain, as it's already being done in the UK [34].

[18] For instance, the Australian government is at the forefront of developing legislation to support a national, voluntary biodiversity market, with approved certification and monitoring. For more information, see here: https://www.dcceew.gov.au/environment/environmental-markets/biodiversity-market.

The public sector disposes of several financing systems to finance nature restoration. Some examples are Payments for Ecosystem Services (PES), biodiversity-relevant taxes and subsidies, and Official Development Assistance.

1. **Payments for Ecosystem Services (PES)** run on the principle that beneficiaries of ecosystem services should pay people and businesses who are providing them. It creates a system of financial incentives for local actors who provide these services, such as forest managers that preserve mangrove coastal forests. There are currently several PES programs, which are mainly based on the costs of maintaining the ecosystem service (e.g. [41]–[43]). In all PES systems, the beneficiary of the ecosystem service pays for it. These beneficiaries can be tourists, governments, or citizens. Currently there are more than 550 PES schemes around the world, with annual transactions estimated to be between US$ 36 and 42 billion, mostly coming from public funds [44], [45].[19]
2. **Biodiversity-relevant taxes** are aimed at activities with a negative impact on nature such as pesticides, fertilizers, forest products and timber harvests. There are currently around 206 biodiversity-relevant taxes in 59 countries [30].
3. **Biodiversity subsidies** include programs for forest management and reforestation, agriculture, and land conservation, and are currently in place in 24 countries [46].
4. **Green and blue bonds** are also used to restore nature, though their focus remains climate - it is estimated that only 4% and 2% of the bonds' proceeds go to, respectively, biodiversity and sustainable land use [47].
5. **Official Development Assistance (ODA)** is an international funding scheme targeted for developing countries [48]. USA, Germany, France and Japan are the main donors of biodiversity-related ODA, with the main projects being about the sustainable management of forestry, water supply, agriculture and fishing in African countries [49]. Multilateral ODA are possible thanks to the mediating and financing role of Multilateral development banks (MDB), with the formula of blended finance. International schemes catalyse a significant part of the public money allocated to biodiversity restoration (around 5-12% of the overall funds spent) [48].
6. **Debt-for-nature swaps** can be used by developing countries to receive a debt or interest discount, and in exchange must invest the related savings into nature preservation and restoration. Countries have been using these instruments quite successfully, leading to around US$1 billion of cancelled debt so far, and approximately US$500 million of savings reinvested in conservation.

One of the newest tools is the Global Biodiversity Framework (GBF) Fund, established during the last Conference of the Parties on biodiversity, COP 15. The fund will complement existing financing systems, with the goal to mobilize at least US$200 billion per year by 2030 [50, p. 15]. The funding mechanisms that we will propose below can regulate and channel payments from the private sector into this fund.

The private sector contributes only marginally. The private financial sector is currently investing in biodiversity restoration, with investments between US$ 6 and 13 billion a year

[19] They focus on different ecosystem services, namely biodiversity conservation, carbon sequestration, landscape amenities and hydrological services [44]. PES have 4 main problems. First, the landowners could have protected these ecosystem services in any case for their own interest. Second, protecting an ecosystem service covered by the PES might mean destroying another one that is not covered. Third, PES create an incentive to landowners to degrade ecosystems in anticipation of a PES scheme being put in place. Fourth, reforestation (ecosystem function) may not always lead to an increase in ecosystem services [43].

[48], [49]. However, this is very little compared to the loans and underwriting services to sectors that harm biodiversity, which amounted to US$2.6 trillion in 2019 alone [51]. While this is the case, there are some signals that efforts are increasing.

The private sector too disposes of several financing mechanisms for investing in natural capital. At the moment, most of the sustainability-related investments from the private sector focus on transitioning towards more sustainable practices, such as sustainable agriculture and low-carbon energy production [52]. This is different from investing in actual nature restoration. This trend is partially explained by the lack of profitability of the restoration activities, driven by the mentioned wedge between market and accounting prices (or the true cost). Tools available for the private sector to invest in nature are green bonds, sustainability-linked bonds, private equity funds in supporting biodiversity, and environmental impact bonds [46], [49], [53], [54]. The low financial returns, the small size of restoration projects and the lack of data and transparency on impact are clear barriers to bring these private funds to scale [52], [55], [56]. Alternative mechanisms that address these barriers are blended finance, pooled funds and private funds for nature like the one of HSBC [57].

Overall, governments have put in place several systems to price and preserve natural capital. The most advanced systems are the ones related to climate objectives, with a fair degree of centralization, achieved via international carbon markets. On the other hand, systems for the preservation and restoration of nature and biodiversity are currently quite heterogeneous and decentralized. This is partially due to the lack of a commonly accepted unit of measure for biodiversity.[20] Possible shortcomings are a low degree of coordination on the choice of restoration projects to be financed, and a low involvement of the private sector in contributing to the restoration efforts.

[20] Among the ones available, there is the Mean Species Abundance (MSA) indicator, which is the mean abundance of species in disturbed habitat relative to their abundance in undisturbed habitat, and the Biodiversity Intactness Index (BBI), which is the fraction of naturally present terrestrial biodiversity that still remains (e.g. [58], [59]). Recently, market participants have proposed methodologies to measure the impact of firms on these indicators, such as the Biodiversity Footprint for Financial Institutions (BFFI) [60] and the Global Biodiversity Score [61].

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