Valuing Natural Capital

New ideas for a sustainable future

Issue Paper

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Geneva macro Labs

Background

The Geneva Macro Labs are organising together with its partners, Harvard Economics Department, the International Labour Organisation and the United Nations Institute for Training and Research, and the UNCDF, the "Valuing Natural Capital" conference (VNC2022) and several trainings in this context. The focus of the conference will be to explore different natural carbon sinks and the contribution they can make to help address climate change. VNC2022 is a call for action to promote tangible, impactful, scalable solutions to climate change by connecting climate and finance.

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Summary of the key issues

What is natural capital?

- What are the key contributions of natural capital? For climate change? For biodiversity?
- What would be consequences of a further erosion of the existing stock of natural capital?
- How much would conservation of natural capital contribute to mitigate climate change? How much would an enhanced conservation of natural capital cost?
- How can we best identify where and which type of natural capital we need to prioritise in conservation efforts?
- How can we best preserve and increase natural capital that combats climate change?

What can be done to preserve natural capital?

- What types of governance mechanisms can help protect natural capital?
- Which ones are particularly effective? Which ones are least effective?
- How can new technologies help to strengthen the protection of natural capital?
- How much do different governance mechanisms cost?

How are conservation and restauration efforts being financed?

- How can resources be best mobilized to protect natural capital?
- What regulatory mechanisms need to be put in place at the international level?
- What type of new standards need to be established to effectively value natural capital?

How can conservation efforts help to improve livelihoods?

- How can protecting natural capital help with economic development?
- What governance mechanisms exist for triple wins?
- How can a just transition be achieved?

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Nature is our most important resource in the fight against climate change. Implementing solutions to finance its conservation and restauration should become our highest priority.

Setting the stage

Slowing and ideally stopping climate change has become the defining feature of our times. Disagreement ensues not regarding the objective but rather how to achieve it. Radical solutions to completely change our way of life clash with techno-optimistic proposals to engineer our climate. So far, none of the approaches taken have managed to substantially lower global CO_2 emissions. On the contrary, our current way of life is threatening to significantly overshoot the net-zero target even by 2050. Much effort is currently being deployed to reduce our emissions to help keep the carbon budget within its limits. This won't be enough, however. Enhancing the planet's capacity to absorb carbon dioxide from the atmosphere and to sequester it needs to become a key building brick in the global strategy to fight climate change. Our biosphere already does an amazing job at extracting atmospheric CO_2 and burying it in trees, mangroves, seagrass and the oceans, to name but a few. These and other nature-based solutions for carbon sinks play an essential role in regulating the climate. But they are threatened by rising temperatures and human interventions in eco-systems.

Simple conservation efforts often collide with local development goals or are undermined by a lack of financing that threatens the economic viability of many such projects. Various governance mechanisms have been tested, often financed through philanthropic efforts. But natural reserves or maritime protected areas fail to make a significant dent in preventing the deterioration of the protected eco-systems and fail to scale up.

A new paradigm is needed, one that recognises how essential the services are that nature delivers to regulate the climate and to preserve a diverse and thriving biosphere. The ecological value of these services is straightforward, but they can also be measured in economic terms: **climate change has a cost by destroying livelihoods if not lives directly. Preserving and restoring nature means recognising the importance of the services delivered by the environment to our own survival**. A thriving biosphere delivers a value that is currently not properly reflected in our way of life. Valuing natural capital, therefore, is accounting for the damage we do to the environment and ultimately to ourselves.

Setting the stage for nature-based solutions, the issues paper provides an overview of various governance mechanisms to protect ecosystems, describing their mechanisms, effectiveness, and shortfalls in protecting the underlying natural asset, whether an individual (keystone) species or an entire ecosystem. Without being exhaustive, the issues paper also discusses the potential of current governance mechanisms to support economic livelihoods for populations living with or in close vicinity to the ecosystem in question.

The issues paper will also look into alternative, innovative financial mechanisms to provide the protection of natural assets. Setting out the logic of turning natural assets into natural capital by valuing their ecological and economic services, the issues paper discusses how both decentralised financial operations and government-led efforts help strengthen incentives for eco-system maintenance and restauration. At the one, innovative end, these proposals include digital tokens of individual eco-system services. On the other, more traditional approaches include debt-for-nature swaps and green bonds. The issues paper will highlight the importance of finding solutions by which such financial mechanisms can address the challenge of international collaboration and cooperation as a key impediment to current efforts to design and implement effective climate change policies.

Finally, the issues paper highlights the potential of various governance mechanisms to provide triple wins: for mitigation, for adaptation and for development. The issues paper will offer various perspectives of how protecting natural capital can become a driver of local economic development, support just transitions to a green economy and provide new resources for an innovative and dynamic economic system. Identifying the important positive feedback loops between safeguarding ecological systems and providing broad-based economic development and livelihoods will be an important part of the conference and hence the issues paper.

Natural capital for the common good

Natural capital refers to the fact that our biosphere delivers essential services to our own survival, be it in the form of regulating the climate or generating biodiversity that allows us to feed, heal or simply enjoy nature. Similar to other forms of capital – land, machines, buildings – natural capital needs to be preserved in order to be able to deliver these services. Exploiting it for other uses, for instance by cutting down trees to generate timber or hunting elephants for their tusk without regenerating what has been extracted will destroy not only nature but also the essential services it delivers. Currently, however, our economic system has relied to a large extent on extracting value from the biosphere without renewing it, significantly contributing to worsening climate change.

Ecological and economic services to be preserved

At a minimum, therefore, further erosion of the existing stock of natural capital should be prevented to preserve the carbon dioxide currently stored in the biosphere. Recent estimates call for the conservation of at least 30 percent of the earth' surface over the next decade, nearly a doubling of current efforts. How to achieve these and where to deploy the most effective conservation efforts remain matter of debate. Yet the benefits in terms of both slowing global warming and improving livelihoods can be significant. Reverting deforestation to allow forests to regrow alone could contribute to 4 to 12 percent of the annual CO2 emissions budget needed to limit global warming to 1.5 degrees. Similarly, job creation through conservation management could add around half a million jobs and support local economic growth. [1]

None of these efforts might be enough in and of themselves. Indeed, it will be important to identify which species and eco-systems contribute which services and how valuable these services are to us. Nevertheless, natural capital can only complement our efforts for reducing carbon emissions, and not be a substitute for it. [2]

What is Natural Capital? Some examples

Amazonian rainforest

The Amazon rainforest stretches across nine South American countries and covers 6.7 million km², making it the world's largest forest and one-third of the world's tropical rainforests. There are more than 40,000 species of plants, 427 mammals, 1,294 birds, 378 reptiles, 427 amphibians and about 3,000 species of fish, making up 10 per cent of the known species on our planet. Indeed, there are 200 to 300 species of trees per hectare in the Amazon rainforest, compared to only fifteen or so in the temperate forests of Europe, hence its nickname of "world biological reserve". A key benefit of the variety and density of plants in the Amazon basin arises from its capacity to store approximately 100 billion metric tons of carbon, more than ten times the annual global emissions from fossil fuels. This ecological contribution is essential for the planet.

Nevertheless, the Amazon rainforest is threatened by deforestation brought about by extensive agriculture and timber production. Thanks to the significant profits it generates, countries such as Brazil specialized in the primary sector to become an agricultural power. Since the 1990s, Brazilian agricultural production has doubled, and animal production has tripled. In 2015, agricultural products accounted for 42% of Brazilian exports, that is more than 5% of total agricultural exports worldwide. As a result, between 1978 and 1988 the average deforestation area was 20,000 km² per year, in the early 1990s it dropped to 15,000 km² per year before increasing considerably to reach a cleared area of 29,000 km² in 1995. After this record, there was a decrease in deforested areas. But deforestation resumed in 2001-2002, peaked in 2004 and continues to increase today.

As deforestation accelerates, the capacity of the Amazon rainforest to absorb CO_2 has declined significantly. Together with global warming and various forest fires, the Amazon rainforest recently started to emit more CO_2 than it absorbs. And the number of forest fires continues to rise. Indeed, the Brazilian Space Agency INPE shows 2,562 fire hotspots have been recorded in the Amazon during the month of June which is the highest level since 2007. [3]

Great Whales

Individual keystone species such as Great Whales are also a significant contributor to ecosystem stability and provide important ecological services. Whales produce at least three ecological services that can be valued: carbon capture, fisheries enhancement but also ecotourism. Their capacity for carbon capture alone constitutes a significant economic and ecological value. Indeed, each animal sequesters up to 33 tons of CO_2, on average over its lifetime, which, when it dies, sinks to the ocean floor and remains sequestered there. Over the course of its life, the whale captures the equivalent of USD 2 million worth of carbon. In addition, whales also contribute greatly to regulating phytoplankton via the food chain krill-whales-phytoplankton-krill. Thus, the activity of whales contributes to increasing the productivity of phytoplankton, which captures yet another 37 billion tons of CO_2 per year. Overall, their contribution to the ecosystem per year is equal to the GDP of

the countries between Greece and Bulgaria and it evolves according to the market prices of carbon emissions. [4]

Despite the economic and ecological value of great whales, their population is threatened by human activities such as entanglements in commercial fishing gear, ship strikes and climate change that leads to rising ocean temperatures. Commercial whaling, once a key danger to their population has, fortunately, declined significantly but continues to subside in protected sanctuaries despite an international ban. Overall, this has led to a significant reduction in the number of whales. Indeed, the whale population before human activities was equivalent to about 4 to 5 million. Now, the total number of whales is barely more than 1.3 million, drastically limiting the services provided by the mammal.

Sea grass

Seagrass is a plant found in shallow salt water, actively shaping undersea landscapes, and providing shelter for water animals, thereby benefiting the maritime ecology. It is fundamental to the biodiversity within the ocean as one meter square of seagrass can generate 10 litres of oxygen, capture sand, dirt, and other silt particles. Additionally, the carbon emission present in the air is used by seagrass beds to build their leaves, resulting in an estimated 83 million metric ton of carbon that is captured by seagrasses yearly. This represents a significant economic value as one hectare of seagrass is estimated to be worth over USD 19,000 per year, being the third most valuable ecosystem in the planet. [5]

These ecological benefits have a direct impact on the biodiversity of the ocean, as they are part of the food system for many species in the water, thus also having long-lasting economic impact on maritime markets. Nonetheless, human's impact has been proven by the yearly 1.5% lost in this system, due to a combination of factors such as fertilizers or air pollution that block the needed sunlight for seagrass growth. Furthermore, the frequent removal of fish and use of boat anchors have been shown to have a direct casual effect on the health of seagrass beds. Limited attempts to restore seagrass through "underwater gardening" have been tried in the UK but remain too small to this day. Globally, the decline of seagrasses in area accounts for a loss of roughly 29% since the beginning of the 20th century. [6]

Mangroves

Mangroves are a type of tropical forest known for its great resistance and ability to thrive in hot, muddy and salty environments. They are being regarded as one of the most valuable systems found in nature, providing great ecological benefits not only in terms of capturing carbon emissions. For example, their ability to provide detritus, found within the fallen leaves and branches of mangroves, provides several habitats to animals such as birds or reptiles. The benefit of this system is best exemplified by their ability to adapt to saline environments, by filtering the salt from the water, or to low levels of oxygen. The biggest benefit mangroves provide stems from their capturing of carbon dioxide amounting between 50 and 220 metric tons per acre of CO2 during their growth period.

Moreover, they provide economic benefits of up to USD 57,000 per hectare per year to the national economies of developing countries with mangroves. Nevertheless, human activity has been highly damaging to mangroves, contributing to a loss of about a quarter of mangroves in the past 40 years. Several investigations into mangrove restoration projects have brought to light key problems linked to a lack of scientific research behind the restoration process. [7]

Elephants

Elephants, such as the African forest elephant, provide essential eco-services to the forests they live in, such as through their dispersal of seeds, especially those from trees that have a high carbon content. Moreover, as individual animals and because of their large size, forest elephants can store more carbon in their bodies than most other species. Since the average body mass of a mature forest elephant is 3000 kg, and each individual body is 24% carbon, then these elephants store about 720 kg of carbon. This ability to store CO2 helps to stabilize the climate, which can be finely assessed. According to carbon market prices in 2019, the services provided by an elephant amounted to USD 1.7 million. With a current population of forest elephants estimated at 400,000 animals, this amounts to an ecological wealth at the tune of USD 680 Billion. [8]

Despite the ecological benefits brought by elephants, their survival is threatened by human activities, including hunting them for their tusk or through indirect effects from extensive agriculture. Global warming further deteriorates the habitat of elephants, for instance through a rise in the global sea levels. This directly affects elephants found along coastal areas as they will have to swim longer distances to survive or live in submerged habitats. Not only does this limit the ecological benefits of the African forest elephant. It also prevents some of the poorest countries in the world from valuing their natural services properly. Just by preserving its current population of elephants and valuing their eco-services, a country such as the DRC could add almost USD 1 500 to its current per capita income, a 250% increase that would come to the benefit of those populations that act as stewards of eco-system protection. Nonetheless, the solutions proposed to help their preservations fell short as many countries, have rejected the idea of fully banning ivory trade, due to short-term economic benefits. In fact, despite the 1989 vote to ban completely ivory trading, some countries have argued to reinstate limited trading in areas that have seen significant elephant growth in the past decades.

How can natural capital be preserved? Alternative governance mechanisms

Various governance mechanisms have already been put in place to conserve and restore eco-systems and protect keystone species. We focus on four of them: natural reserves, environmental taxation, payment for eco-system services and supply chain management. Mechanisms might depend on the underlying eco-system that is to be protected. An overview of alternative governance mechanisms for ocean assets can be found here: [9]

Natural reserves and protected areas

Created by delineating zones with permitted and non-permitted uses, implementation begins with identification of threats and impacts of the site, followed by developing management and monitoring proposals with governments and organizations combined. Specific objectives and regulations can vary across protected areas, for example what is permitted in strict nature reserves may differ from that of national parks

Key benefits

Natural reserves such as Marine Protected Areas (MPA) offer more financial stability than carbon markets by securing resource supply and stable regulation. They provide a living laboratory to further conduct research. Protection encompasses not solely individual species, but entire ecosystems. They allow for addressing the interlinkages between land, water, and living resources. With the 2030 agenda in mind, an estimated 400,000 to 650,000 jobs could be created in conservation management fields and infrastructure. [1]

Key challenges

Ineffectively managed natural reserves can cause tensions with industries. For instance, MPAs conflict with commercial fishing and others interests who wish to use the water in ways that violate regulation, such as possible negative economic impacts on tourist operators and maritime transportation. Difficult and expensive to survey, monitor and enforce protection large areas, in particular when outside individual jurisdictions (e.g., international waters). Protected area systems still need the assurance of sustainable, long-term funding that can help (by creating enabling economic conditions and by providing funds for emergencies).

Example: Belize MPA network

In Belize there are 14 MPAs along with 13 protected sites for the spawning aggregation of fish. While 23.5% of these areas cover Belize's waters, only a small portion consists of no-take areas. An initiative started in 2013 for the establishment of replenishment zones (zones for fish to grow larger in population). Currently 7.6 per cent of Belize's waters consist of no-take zones. This number must increase to a minimum of 10 per cent in order for the successful conservation of marine biodiversity. Successful no-take zones require compliance from fishers which was pursued by the government through managed access to fishing in waters. Enforcement was further implemented with the Spatial Monitoring and Reporting Tool (SMART) which enabled patrols to monitor human activity such as hunting and fishing. Today this cost-efficient technology is used to more easily detect illegal fishing and point out high-priority areas. This has led to an 85% decrease in infringement on protected marine areas. [10]

Environmental taxation (ET)

Environmental taxation is a governance mechanism which serves to minimize pollution on a macroeconomic level. The most popular form of taxing environmental effects is done through carbon pricing, raising the relative cost of pollution to the environmental effects of certain economic activities. Environmental taxation initiatives can either directly regulate the price of certain activities (tax) or impose an overall quota on a sector's level of pollution (emission trading schemes). Carbon pricing initiatives are prevalent in both North America and the European Union. While carbon taxation makes up 3.6 per cent of the global emissions of advanced countries, the ETS option is more popular making up 13 per cent.

In order to set a price on carbon, governments consider the external costs of greenhouse gas emissions such as damage to crops and health care costs from natural disasters such as flooding, heat waves and droughts. Pricing carbon shifts the burden to those responsible for it and forces them to reduce it. A carbon tax sets a price on carbon emissions by companies and internalizes this into their production costs. The revenue the government receives from carbon taxes can subsequently be invested into sustainability projects. [11]

Key benefits	*Key challenges*
Macro policies of taxation are deemed some of the most effective ways to offset emissions as they provide direct economic incentives to reduce pollution/carbon emissions. Carbon pricing is also considered a relatively less costly approach to mitigating climate change.	Emission trading schemes, although more popular than carbon pricing, are a complex mechanism and its effectiveness may therefore be lower in developing countries with weaker institutions. Moreover, when implemented through a carbon emissions trading platform, carbon prices can be very volatile, which weakens predictability and incentives for pollution reduction.

Example: ETs in Costa Rica and Colombia

Carbon taxes are effective in reducing greenhouse gas emissions by incentivizing reduced usage of fossil fuels. This is critical for countries with the Amazon rainforest within their borders, as the Amazon rainforest absorbs 5% of global carbon emissions every year.

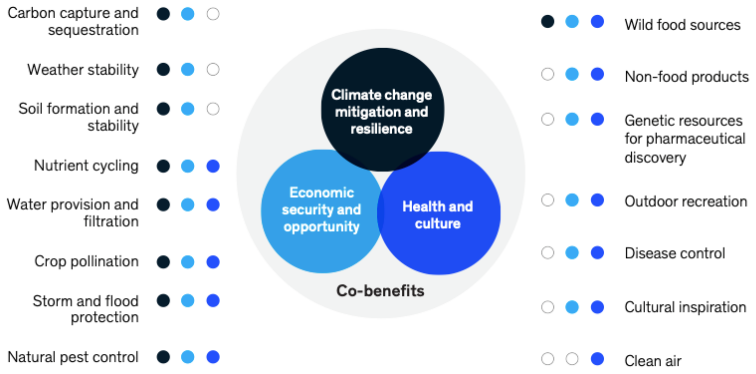
Costa Rica implemented carbon taxes in 1997 which has restored and protected a quarter of land across the country and generated CRC 26.5 million of revenue every year. The revenue is then given to farmers and landowners to fund the restoration and protection of their property.

In Colombia, similar initiatives have been taken, placing a tax on liquid fossil fuels. The tax revenue is partly used to fund projects to protect forests and companies are able to get a tax break if they themselves initiate the reduction of carbon pollution. [12]

Payment for eco-system services (PES)

Natural capital provides a wide range of ecosystem services with direct benefits to humanity. PES is a mechanism that pays landholders for managing ecosystems in ways that benefit others. This provides landowners with an incentive to maintain natural capital that provides the ecosystem services. The beneficiaries may be individuals, communities, businesses, or public bodies. One example are "debt-for-nature" swaps where highly indebted countries receive debt relief in exchange for restoration efforts of natural capital. [13]

Payments can be made by beneficiaries of the environmental services, such as water users and hydropower companies. In other cases, payments can be made by indirect beneficiaries such as national or local governments. Furthermore, the role of the private sector is growing among PES schemes at both international and local levels. While the scheme is widely used on land, coastal and marine ecosystems are becoming a focus of this market-based mechanism



Key benefits	*Key challenges*
PES schemes are flexible, easily applied and cost-effective, allowing high customization to local circumstances. PES offer distributional benefits, if communities can improve their livelihoods by offering and selling their ES. PES provides a potential platform to integrate conservation and climate efforts into a common policy framework, and facilitates the transition from an economy of production to an economy of stewardship	A problem for the implementation of PES is weak ownership and tenure rights of forest land. Forest tenure must be clearly defined and recognized and the ecosystem service provider must hold the rights of the service as a pre-condition. Transaction costs also occur while arranging and signing contracts, including economic assessment and information costs, contracting and monitoring costs.

Example: Bhutan's innovative conservation program

Despite being the one of the smallest countries on our planet, Bhutan's commitment to innovative conservation is bigger than most. The government of Bhutan has established three PES schemes, in accordance with one of the four pillars of the Gross National Happiness agenda. In Yukpugang, members of the community forest and the Dzongkhag Water User Group initiated in 2010 a PES, that incentivises the community members to protect the forest from excessive grazing and over-harvesting. Thus, watersheds upstream are maintained and resulting in better water yield. Aside from protecting the recharge zone, the community have to carry out other tasks such as cleaning the stream, afforestation and guarding against illegal logging. The scheme has successfully protected the water source for residents around the Mongar region, leading to a renewing of the scheme in 2020, with parties agreeing to extend the contract term from five years to 10 years. [14]

Supply-chain management for protection

Supply chains face significant challenges to improve their sustainability. The increasing power of multinational corporations has allowed them to avoid repercussions for their harmful actions towards local communities and the environment. To avoid polluting activities being outsourced to countries with lower environmental standards, supply-chain restrictions on pollution (or human-rights violation) might be imposed that hold downstream companies liable for the pollution of their entire upstream suppliers. [15]

To enforce and monitor such restrictions new technologies can help improve traceability. Blockchain certificates, for instance, are one potential way to trace environmental activity more easily across supply chains. Companies can use blockchain applications to track activities with more accuracy. Blockchain can also be used to track raw materials so that they come from sustainable locations.

Key benefits	*Key challenges*
New legislation holds large corporations accountable. This forces corporations to track the sustainability and environmental impact of their company across their supply chain. New technologies such as supply-chain management via blockchains does not require strong legal protection or administrative capacity, making it advantageous for governing common resources. Blockchains are relatively accessible requiring cheap technology. Blockchains and tokenization could potentially democratize investment and address invisible labour. Blockchain technology would allow for self-enforcement of rules.	Multi-national companies find it difficult to track the full environmental impact as they may not be directly dealing with all suppliers to which production is outsourced. [16] New technologies might not always be available. For instance, Blockchain technology is currently only available for 'sophisticated' suppliers. There has to be balance of what actions are tokenized. Blockchain technology use may be biased towards those who code and create the blockchains. There may be general distrust within communities of the new technology.

Example: The UK's Environment Act

An example of legislation for the sustainable management of supply chains is the United Kingdom's environment act that was issued in 2021. The UK is making it illegal for businesses to use products that do not align with local laws serving to protect natural areas. Materials and products such as palm oil, cocoa, rubber and soy therefore have to have been produced under laws to protect natural resources such as forests. The companies would have to carry out due diligence by publishing where their resources are acquired. Failure to comply with 'due diligence' would result in potential fines. Similar legislation has been adopted by the European Union to hinder environmental and human rights violations within raw material industries such as timber, garment and leather production. However, this 'due diligence' law faces challenges as there is no established repercussions for companies. Holding companies liable under law may be a challenge due to various loopholes. For instance, under the EU 'due diligence' law, companies can simply shift the responsibility to suppliers. [17], [18]

Financial solutions for preserving natural capital

Financial solutions to protect and leverage natural capital require both the development of new private finance instruments and a well-development market (infrastructure) supported by public activity. **What options exist to mobilize financial resources to fund conservation efforts?**

Tokenisation and Decentralised Finance (DeFi) Solutions

Tokenization is the possibility to create a digital twin for an asset, such as a tangible object, a virtual object, a right or even an idea that can be transferred and traded as a whole or in fractions. The process implies a series of technical and legal procedures to upload asset ownership to a digital ledger, for instance a blockchain. In the case of natural capital, this would allow to identify individual species or entire eco-systems as possible recipients of conservation and restoration payments in exchange for carbon credits.

A key component of blockchain technology is its immutability. Just as the tech has been used for supply chain management/oversight, a credit token's creation, changes in ownership and use can be accurately mapped. Gaming the system by altering a credit's status (perhaps after it has been spent) is made impossible through blockchain's immutability and a system of decentralised consensus. Moreover, token exchanges could enhance the liquidity on carbon offset markets by allowing more types of natural assets to enter the market. This greater access should provide the market with more liquidity and if so, this would allow more accurate and updated bid-ask spreads to be displayed to investors. Currently, exchanges do not have enough data and volume of exchanges to be displaying these accurately. Finally, it can help create an international exchange of carbon trading credits and carbon capture solutions and hence overcome the current market dislocation between the supply of funds and demand for investment into environmental welfare projects. This could provide a solution independently from international agreements and would only require support by local policy makers.

Yet, decentralised finance solutions face significant uphill challenges. For one, reducing the volatility of the price of carbon is vital to the success of the offsetting markets. The more stable they are the more investors will be willing to commit long-term capital. However, not only have carbon prices fluctuated significantly, they differ considerably across trading platforms (e.g. the EU ETS, California Carbon Credit Market, and Voluntary Carbon Markets, such as the nature based offset and aviation industry carbon offset markets). For example, in the EU ETS, carbon credit supply is set by government policy whereas demand is principally driven by energy prices, macroeconomic growth and major socioeconomic/geopolitical events. However, in the VCM carbon prices can also differ by project type, the age of carbon sequestration, size of transaction and the Standard used (e.g. Verra, Gold Standard, CAR, ACR). One example of this difference is that the price of carbon credits through Biogas-related projects is greater than Wind power-related projects. As markets are highly segmented, liquidity is low, one key factor behind high volatility of carbon pricing.

Second, **there is currently not an internationally/nationally accepted standard for Nature Based Solutions (NbS) and thus there is no regulatory body responsible for protecting investors. The issue is that often these NbSs are based in less developed countries where regulation is weaker where the governing bodies have less control or legal power to protect property rights/investors' capital.**

Therefore, what role should regulators in say the US/UK/EU (where the investors/companies may well be based) play in their domestic markets? With very little regulation in the DeFi industry currently, how well equipped would potential regulatory bodies be to manage the combined industry of DeFi and nature-based offsetting in the case of tokenisation. Without this regulation/investor protection, NbSs (with tokenisation) will remain a riskier investment, which may very well dissuade many interested investors that would have a significant appetite (and pot of funds) to invest in such programs.

Finally, blockchain-based solutions raise issues of sustainability themselves. Notoriously, the first generation blockchain system requires an immense amount of electricity (most often produced through carbon-intensive means) to operate – most famously Bitcoin. This is due to them using the proof-of-work system. However, new consensus mechanisms have been introduced, notably proof-of-stake, that significantly reduce the first generation blockchains high energy cost. In the second half of 2022, Ethereum will transition to a proof-of-stake system, dubbed *The Merge*. It introduces a highly scalable multi-level blockchain architecture which not only solves the energy consumption problem, but also scalability issues. After all, despite its immense energy consumption, Bitcoin only allows seven transactions per second. The success of this new Ethereum system will be significant because Ethereum is the basis for thousands of crypto currencies, tokens systems, DeFi and other smart contract based blockchain applications.

Social Climate Fund

Currently, the receipts of carbon offsets and environmental taxes are recovered by (national) governments and mostly used for other, often non-environmental purposes (e.g., reduction in labour taxes as done in Germany). Instead, these receipts could fund a social climate fund that is being used to finance preservation efforts (e.g., MPAs and PES) including in other jurisdictions. A lighter version of a Climate Fund would be to issue green bonds to direct financing towards certain environmental purposes. Such a fund could promote green transition via public expenditure/investment in green transition projects. This can be complemented and supported through green monetary policy by helping policy makers to raise funds specifically for environmental action. One key benefit of such a Climate Fund would be to generate sufficient liquidity in the market that helps reduce the volatility of carbon credits. In particular, such a fund could absorb price fluctuations through its own reserves, something individual investors are not easily able to do.

Yet, several challenges emerge, often similar to the ones for DeFi solutions. Some of the operational risks would most likely be absorbed by the climate fund's budget. Nevertheless, the risk remains that if a project went unfinished and thus no offsets were realised, then the capital that the fund had invested in may be lost. This may dissuade

sovereign climate funds from investing in less developed countries where property rights/judicial system are less well formed, or extreme weather events are more likely. Generally speaking, a bias towards investment in national natural assets will remain, compounded by exchange rate risk with large capital outflows to low-income jurisdictions. Moreover, recipient countries might fear reputation risk/sovereign debt risk of debt-to-nature swaps and other financial flows that affect their balance of payments. Finally, with a climate fund being controlled by a governmentally appointed group/institution, political pressure may arise if a) the results of the fund do not meet the public's expectation; b) these funds are not spent on domestic climate projects; c) a country comes under financial strain and thus the budget of the fund is cut. Unless a clear mandate with well understood expectations and enough independence are set out, political pressure may see a climate fund's performance hampered.

Green bonds

Green bonds offer bond issuers the opportunity to receive cheaper funding, in return for investing in sustainable projects. They are an encouragement for bond issuers to change to a greener business model, much like a rewards system. Investor might choose green bonds to ensure their capital is being worked to support the shift to being more sustainable. This comes at the price of receiving less return on investment as the interest rate on a green bond is typically lower than a conventional one, much like a green premium. Despite the lower ROI, most investors have an ESG criteria upon which their investments' performance is judged too. This price/yield of green bonds is decided by bond markets, with the demand for sustainable investment matched by the supply of corporations willing to issue green bonds. With green bonds very similar in structure to conventional bonds, they fit into the current capital markets and so investors don't have to update their investment analysis.

According to the Climate Bond initiative the size of the green bond market as of 2021 is roughly $1.6trn, growing roughly $523bn that year and compared to a market that was only worth $104bn in 2015. However, with the next target for global green investments at $5trn annually by 2025, the market for green bonds has a significant way to develop and thus faces typical challenges for such a new and fast-growing financial instrument. [19]

At the time of creation, green bond markets were smaller, and issuers needed to be convinced to enter the market. Thus, several standards were created to help set a precedent for the market such as the International Capital Market Association's (ICMA) Green Bond Principles (GBPs), which were formed in 2014. However, there is no globally recognised issuance standard, none with any actionable legal precedence, and they are by definition voluntary to follow. Due to this reliance on voluntary participation/compliance, preventing companies from taking advantage of the market that intend to misrepresent their activities is difficult. The opportunity to raise cheaper (green) capital, while improving one's reputation through mislabelling a bond issuance as green for a very limited cost is a material risk that is difficult to protect against. Thus, if appropriate standards are not widely recognized, the risk for greenwashing cannot be excluded.

Furthermore, there is very little protection for investors in the case that an issuer breaches its green investment mandate. In this event, the issuer is not obliged to immediately repay or increase its coupon payments, which may be the case if a conventional bond issuer was to break its investment mandate. Even though the investor can sell said green bonds, this may well be at a loss and so the onus of the breaching of a green investment mandate would be on the investor. **Fundamentally, this raises the question as to why governing bodies have not stepped in with further regulation to prevent a mismatch between investor and issuer incentives.**

Although there are standards to follow for green bond issuers, there is no single globally recognised code. None have any actionable legal precedence, and so far, they are only voluntary to follow. One prominent one is the International Capital Market Association' (ICMA) Green Bond Principles (GBPs), which were formed in 2014. At the time of creation, green bond markets were smaller, and issuers needed to be convinced to enter the market. Therefore, the current standards and lack of regulation will need to be updated and implemented as the market grows. As long as such standards are not widely recognized, the risk for greenwashing cannot be excluded, in particular if a company has the opportunity to raise cheaper (green) capital, while improving their reputation by labelling a bond issuance as green for a very limited cost. Increased transparency by recording transactions and certificates on a blockchain based system, can help address these problems by preventing double-counting of carbon sequestration measures, for example. Since the green bond market is based on voluntary participation/compliance, preventing companies from taking advantage of the market that intend to misrepresent their activities is difficult.

Want to know more? Some suggested further reading

[1] Valuing nature conservation | McKinsey

[2] Carbon removals from nature restoration are no substitute for steep emission reductions - ScienceDirect

[3] Amazonia as a carbon source linked to deforestation and climate change | Nature

[4] How much is a whale worth? Millions to combat climate change (nationalgeographic.com)

[5] Seagrass and Seagrass Beds | Smithsonian Ocean (si.edu)

[6] Importance of seagrasses: A review for Fiji Islands (ijcs.ro)

[7] The Role of Mangroves Forests in Decarbonizing the Atmosphere | IntechOpen

[8] How much is an elephant worth? Valuing natural capital to protect nature and improve wellbeing - Development Matters (oecd-development-matters.org)

[9] Frontiers | The Role of Blue Carbon in Climate Change Mitigation and Carbon Stock Conservation (frontiersin.org)

[10] Case study: Belize – Towards Expansion of No-Take Areas in the MPA System | Commonwealth (thecommonwealth.org)

[11] Carbon Tax Basics - Center for Climate and Energy Solutions (c2es.org)

[12] Carbon taxes are key to stop deforestation (climatechangenews.com)

[13] Debt-for-Climate Swaps: Analysis, Design, and Implementation (imf.org)

[14] Conserving water resources with PES, an example from Yakpugang | Kuensel Online

[15] Towards a mandatory EU system of due diligence for supply chains (europa.eu)

[16] Starting at the source: Sustainability in supply chains | McKinsey

[17] World-leading new law to protect rainforests and clean up supply chains - GOV.UK (www.gov.uk)

[18] Dangerous gaps undermine EU Commission's new legislation on sustainable supply chains - ECCJ (corporatejustice.org)

[19] Sustainable Debt Global State of the Market 2021 | Climate Bonds Initiative