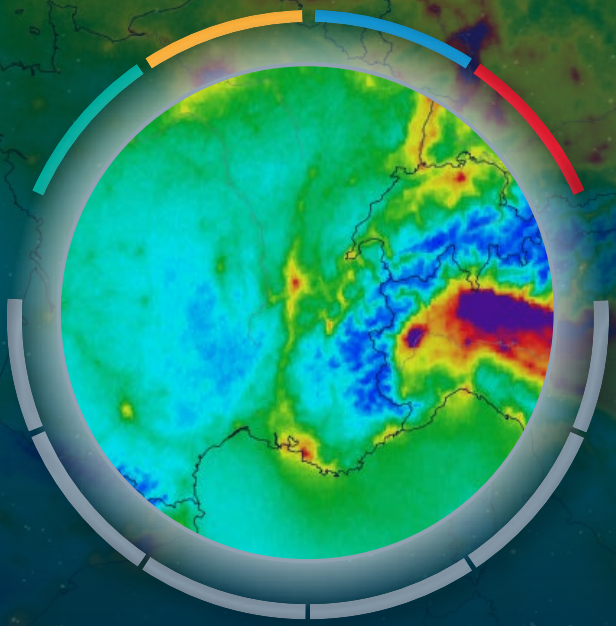


Space for Green Finance

Use Cases and Commercial Opportunities

Introduction

In finance, space added value has often been linked to specific market analysis on economic activities: oil silo occupancy rates, containers in ports, and cars in front of shopping malls being some well-known examples. Commodity trading and output forecasts for renewable energy markets are also frequently mentioned.

With the financial world's increasing focus on sustainability, new commercial opportunities are emerging. Indeed, corporates and financial institutions are facing increasing pressure to take a more active role in the transition to a sustainable future: greening existing brown assets and financing new green assets. However, Green Finance extends well beyond the asset level to also encompass the environmentally- and climate-friendly design of the financial system as a whole and the management of environmental and climate risks within financial institutions. This imperative has been driven notably by common frameworks such as the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 as a universal call for social, economic and environmental sustainability, the Paris Agreement that was reached at the UN Climate Change Conference (COP21) in Paris, and an increasing number of non-financial standards for the industry. In particular, the new EU law on deforestation and the "30 by 30" target agreed on during COP15 in Montreal, to conserve 30 per cent of the planet by 2030, will trigger new demands for remote sensing solutions.

With the transformation of the finance sector and emerging needs for nature-related measurements, reporting and verification, space companies are about to become key partners in the short and medium term. This report examines the current status of Green Finance, its main trends, needs and opportunities, and highlights commercial opportunities for space data and technologies. Its findings are based on desk research, semi-structured interviews, and an online workshop attended by more than 17 high-level panellists[1]. The document aims to further support the space community in navigating in a new sector and raise awareness on the increasing added value of space.

In fact, insurance- and finance-related data and value-added services are forecast to have a CAGR of 21% until 2031, the highest growth rates of any Earth observation services [1]. New scalable data solutions are needed on an asset, corporate and portfolio level to comply with more stringent government regulations, as well as to respond to growing public pressure. Two main areas of particular interest are emerging: Environmental, Social and Governance (ESG), with a specific focus on the "E" and nature-based solutions. A second report will focus on climate risks and space added value. Sustainability and climate-related data needs are seen as the main segments for the commercial uptake of space data.

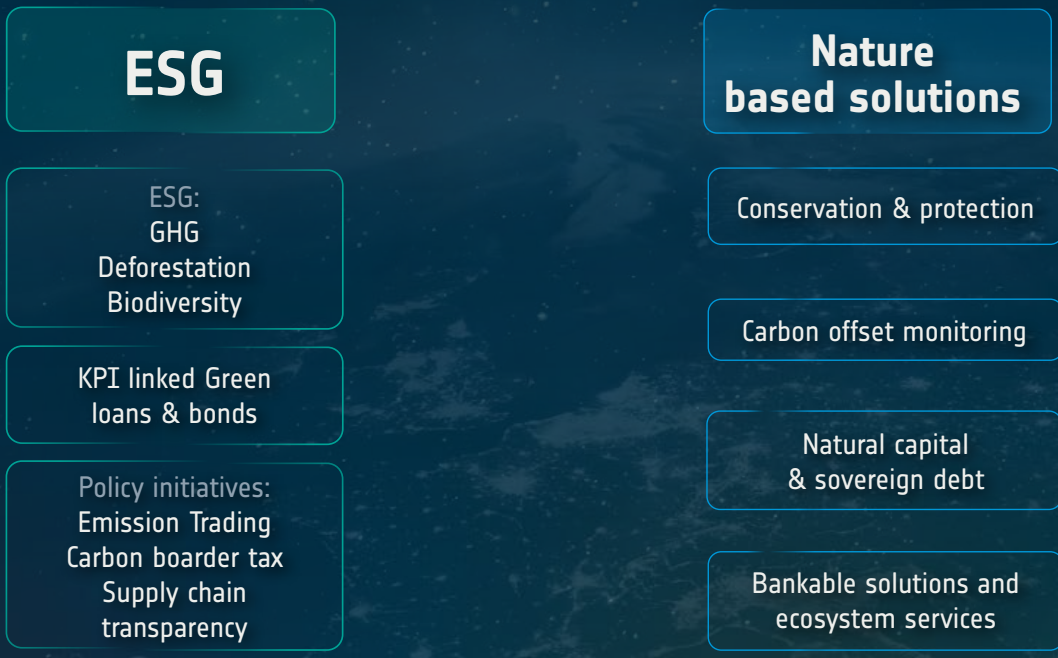


Figure 1: Overview of main green finance use cases identified

1. SPACE FOR FINANCE WORKSHOP: HOW SPACE TECHNOLOGY...

Setting the Scene

The relationship between corporates and their natural environment is twofold: on the one hand the impact of corporates on the environment has to be considered, whether negative, neutral or even positive. In this context, ESG use cases as well as nature-based solutions are of relevance. On the other hand, private and public financial institutions must manage climate and natural risks and verify whether they are appropriately positioned to respond to long-term climate change and short- as well as mid-term risks from natural hazards.

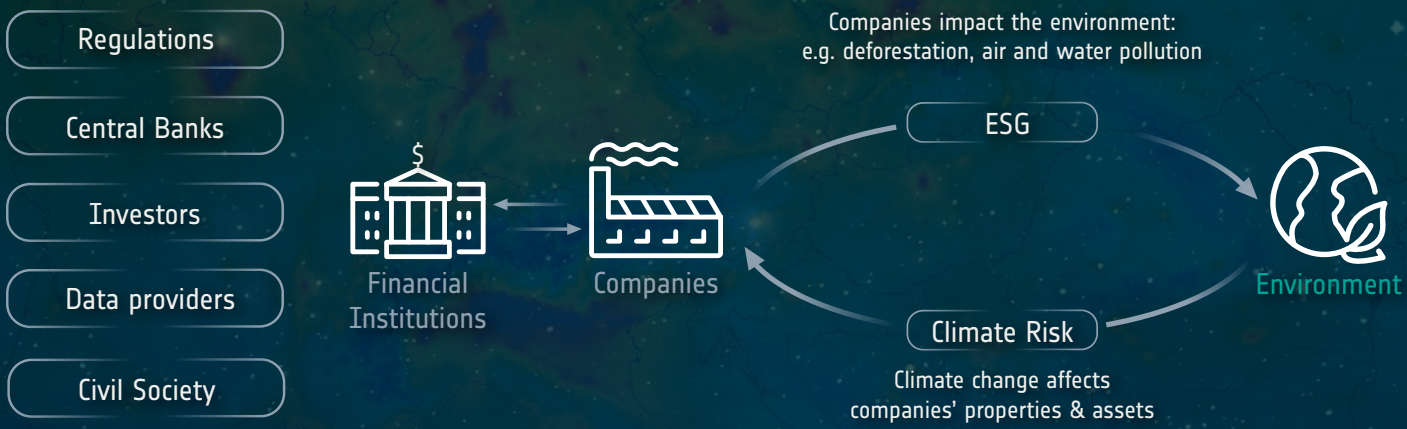


Figure 2: Overview of mutual influence of corporates and their environment

ESG indicators

ESG indicators are data on the sub-asset and asset level. The "E" focuses most particularly on air pollution monitoring and increasingly on areas such as deforestation, biodiversity and water-related pollution. ESG indicators are relevant for credit and investment due diligence and portfolio analysis, increasingly carried out by growing ESG or sustainability teams within financial institutions. While theme- and impact-related investments are still relatively small-scale, they have seen high growth rates in recent years. The estimated current size of the global impact investing market stands at US$715 billion [3]. The majority of the total assets under management in sustainable funds are currently held by institutional investors, even though the share held by retail investors is increasing. For the future, assuming 15% growth, half the pace of the past five years, Bloomberg predicts ESG assets under management could represent more than a third of the projected total US$140.5 trillion global total assets under management by 2025.

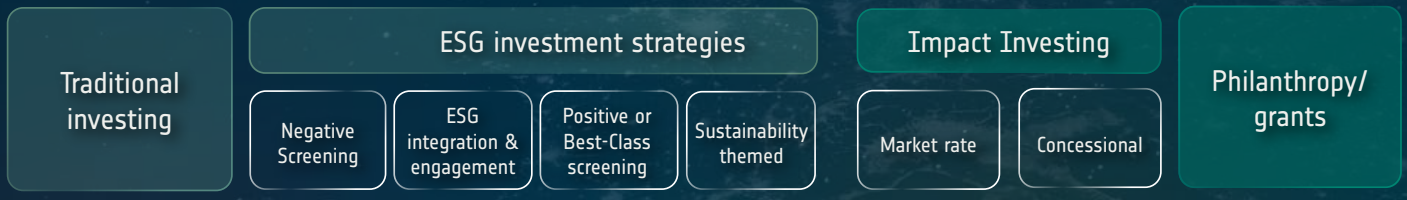


Figure 3: Overview of different investment types, based on GISD Alliance 2020

At the heart of the ESG discussion is the information asymmetry between corporates and their external stakeholders, which include investors, governments, and civil society. Companies themselves often lack the processes to report on how their operations or investments impact on or depend on nature, especially along their own supply chain. Stakeholders depend on voluntary disclosures, often issued once a year, with all the potential issues this entails with regard to accuracy, coverage, and granularity.

In response to increasing public interest and regulatory pressures, an entire industry has sprung up to fill the gap made up of start-ups, rating agencies, as well as consulting, data and engineering companies that analyse and score companies. However, these ratings rarely focus on real (environmental) impact assessments, but instead are based on scoring models placing a greater weight on the "G" part of ESG. As a consequence, science-based targets and real impact measurements as well as tools aligned with international standards are beginning to emerge: a new generation of specialised data providers focuses on alternative data sources and leverages innovative technologies from natural language processing through machine learning to spatial monitoring.

In addition to the information asymmetry, dozens of different ESG disclosure frameworks exist. The most relevant, the "group of five", have made important strides towards developing common standards: **the Carbon Disclosure Project (CDP), the Integrated Reporting Framework, the Climate Disclosure Standards Board, the Global Reporting Initiative, and the Sustainability Accounting Standards Board**. Frameworks are often built on recommendations by the Task Force on Climate-Related Financial Disclosures (TCFD) or the Network for Greening the Financial System (NGFS). The goal is to develop common standards on how data are gathered, how metrics should be created and the way in which materiality should be incorporated. These are relevant for financial supervisors, central banks, banks or investors.

An important driving force for new data demands has been the tightening of regulatory environments: one example is article 29 of the French law on Energy and Climate, which requires all French financial institutions to disclose their approach on biodiversity-related and climate-related risks from 2022[2]. Widely impactful are the new European regulations on sustainability-related disclosure: the **European Union (EU) Taxonomy** is a classification system established to clarify which investments are environmentally sustainable. It came into force in 2020 and has been applicable since 2022. The EU Taxonomy goes hand in hand with the Non-Financial Reporting Directive for corporates and the Sustainable Finance Disclosure Regulations (SFDR) for financial market participants. The UK is working on a separate taxonomy. With these taxonomies, Europe is establishing some of the most stringent rules worldwide. Transparency demands on value chains, like Scope 3 emissions or regulations on deforestation, in particular, are creating new data demands.

2. French investors had to disclose their climate-related risks on a comply-or-explain basis already since 2016. More details on Article 29 in French under: DVELOPING AND DELIVERING A RISK MANAGEMENT AND... The Banque de France has created a climate change centre in April 2021 to understand and improve the climate and ESG performances of banks' portfolios.

ESG-related Use Cases

Pressure on companies to cut emissions is high, not only since the Dutch landmark ruling ordering Shell to reduce its carbon emissions by 45 percent by the year 2030 [4]. Regulations are focused on the reduction of carbon emissions in response to reputational, regulatory and transition risks. Emissions are categorised as direct ("scope 1"), energy-related ("scope 2") and indirect ("scope 3").

At present, there are two main market types in need of data: compliance and voluntary markets – with substantial variation by region and sector, while obligatory reporting of Greenhouse Gases (GHG) emissions is often limited to large, listed corporates.

The dominant standard for self-reported carbon accounting is the GHG Protocol Corporate Accounting and Reporting Standard ("GHG Protocol"). The GHG Protocol, is currently used by 9 out of 10 Fortune 500 companies. Science-based targets, meanwhile, are being developed by the Science Based Targets Initiative. Cost-efficient monitoring of SMEs and corporates in low- and mid-income countries, in particular, remains a challenge. Nevertheless, voluntary carbon markets have seen growth in recent years, driven by net-zero commitments. A recent survey estimated that the voluntary market has an opportunity to grow 15-fold by 2030 [5]. Dedicated carbon emission disclosure projects and commercial platforms are the CDP, Four Twenty Seven (part of Moody's), S&P Trucost, the 2° Investing Initiative, and Transition Pathway Initiative, among others [6].

Despite some progress having been made, emissions levels are based on sparse data creating wide divergence in estimated emissions. Results often provide high-level assumptions that are not based on accurate baselines and with an inability to track changes and progress – or even reward those where they occur. Asset data and attributes are available commercially for a few sectors to a limited degree such as mining, shipping, oil and gas, power plants, fishing and real estate. These data platforms are mostly commercial – so only accessible at a cost – fragmented, and fail to cover all regions, sectors and assets. Gaps are filled by models and indirect measures (Environmental Extended Input Output matrix, regression models, life-cycle data, among others). Scope 3 emissions have the lowest coverage of all disclosures: according to CDP, fewer than half of the companies that disclose emissions data actually track and report on scope 3 emissions.

While carbon dioxide has received most attention, methane emissions are the second largest cause of global warming. The energy sector – including oil, natural gas, coal and bioenergy – is among the largest sources of methane emissions, but efforts to reduce them have often been hampered by a lack of reliable data [7]. The Climate and Clean Air Coalition, a voluntary partnership dedicated to reducing short-lived climate pollutants, or the Global Methane Alliance are emerging forums gathering stakeholders for information exchange. In 2021, the United Nations Environment Programme UNEP and the European Commission joined together to launch the International Methane Emissions Observatory [8]. It will, among other things, aggregate company reporting, satellite data, and measurements from scientific studies.

Furthermore, financial products linked to emission reduction KPIs exist, but are limited in use (e.g. KPI-linked bonds or loans). Industry experts expect a further growth in these instruments and an increasing need for data for monitoring and evaluation.

Emissions Trading Systems and Carbon Border Adjustment Mechanism

Carbon market mechanisms put a price on carbon and help to internalise the environmental and social costs of carbon pollution. An **Emissions Trading System** (ETS), also known as a cap-and-trade mechanism, sets a mandatory limit or cap on GHG emissions for a predefined set of sectors. ETSs exist at regional, national and sub-national levels and cover various sectors [9]. China's emissions trading system came online in 2021 and is currently the largest carbon market in the world, covering around 4,000 Mt CO2 or 30% of its national GHG emissions. The EU ETS covers all EU countries (as well as Iceland, Liechtenstein and Norway) and around 2,000 Mt CO_2 of emissions. Apart from the EU, four countries have enacted national-level GHG ETSs: New Zealand, Switzerland, Kazakhstan and the Republic of Korea. Other countries have announced plans for these systems. ETSs rely on GHG reporting systems with monitoring, reporting and verification requirements. Digital technology innovations can be used when generating and trading carbon credits efficiently, as well as improving access to better data and analytics and helping create well-functioning markets.

A carbon border adjustment mechanism, also called carbon import tax, was presented in 2019 as a key measure of the Green Deal. The European Parliament gave the green light for a pilot to be set up by 2023 to charge imported carbon-intensive goods[3]. While legal and trade implications are being intensively discussed, emission data collection, monitoring and verification remain important operational questions to be clarified. As countries have very different approaches to measuring GHGs, and only a few functioning ETSs are in place in low- and middle-income countries, objective monitoring and verification systems will be required.

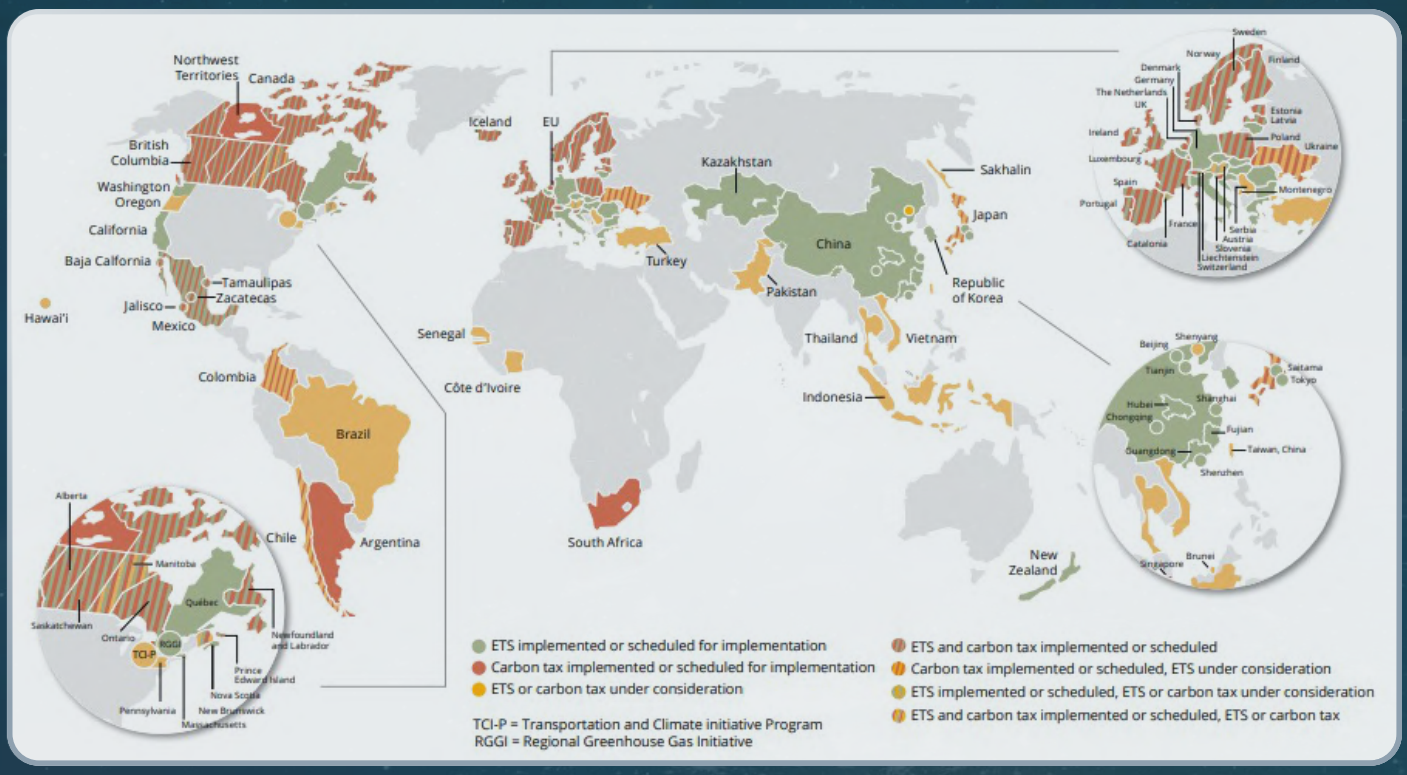


Figure 4: Areas and types of carbon pricing schemes, World Bank, 2021

3. A high level conference on this topics was organised in March 2021 in Paris by the French government. Recordings are available here: [VIDÉO] CONFÉRENCE « UN AJUSTEMENT CARBONE AUX...

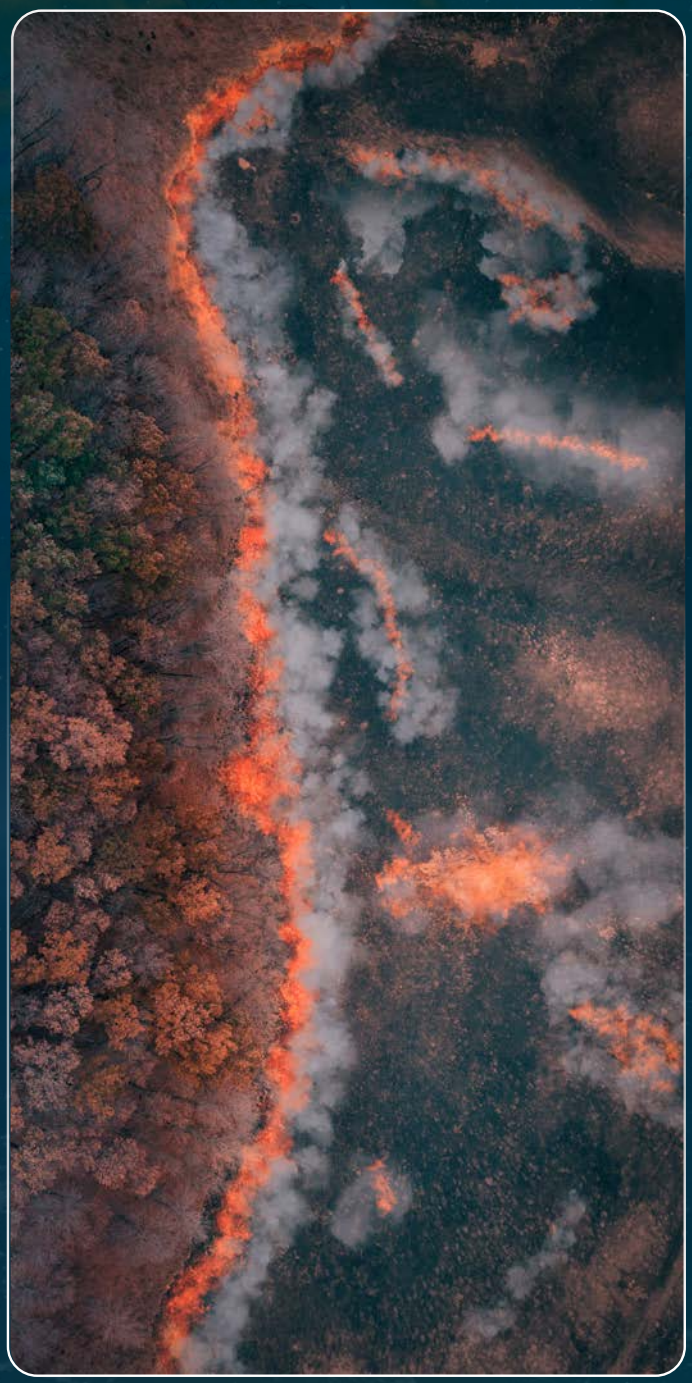
Deforestation

Signatories of the New York Declaration of Forests agreed to "at least halve the rate of loss of natural forests globally by 2020 and strive to end natural forest loss by 2030". Yet, global deforestation currently represents around 10 million hectares per year and nearly 10% of global tree cover has been lost since the turn of the century alone. Agricultural expansion is the main driver of deforestation, especially agricultural commodities – cattle, oil palm, soy, cocoa, rubber, coffee and plantation wood fibre – together they accounted for more than half of global tree cover loss from 2001 to 2015 according to a recent study using spatial data [10]. Cattle replaced most forests by far (45.1m hectares), followed by oil palm (10.5m hectares) and soy (8.2m hectares) [11]. Overall, Brazil, the Democratic Republic of the Congo, Bolivia, Indonesia, and Peru were among the top 5 worst-hit countries for primary forest loss in 2020. In the Brazilian Amazon rainforest, deforestation hit a twelve-year high in 2020. While progress in eliminating palm oil-related deforestation is being made, cattle products and soy supply chains are lagging behind [12].

Companies, but also financial institutions (FIs), are facing challenges in assessing, monitoring and managing their deforestation risk exposure across the value chain, especially in remote areas. In addition, investment flows and supply chains are often long and complex. In the case of palm oil, coffee and cocoa, many small farmers are involved. Local national regulations are diverse and even if deforestation may be illegal in many regions, it is not necessarily prosecuted [12].

Important data sources are Global Forest Watch (GFW) and the United Nations Food and Agriculture Organizations' Global Forest Resources Assessment 2020. Key for FIs is the matching of assets and investments with deforestation activities as is done by Forest 500, which allocates scores both to companies and to FIs. The Dutch Sustainability Finance Platform recently published guidelines on how to handle deforestation for FIs. These guidelines include useful tools and available satellite-based solutions that have been rated the most useful for monitoring and reporting.

Stricter regulations are emerging in most developed economies. The European Commission, for example, proposed in a recent communication the creation of a multi-stakeholder platform and an EU Observatory on deforestation and forest degradation, also focusing on redirecting finance to support more sustainable land-use practices [13]. In 2022, the EU agreed on laws to fight global deforestation and forest degradation driven by EU production and consumption[4]. Operators and traders will have to prove that products are both deforestation-free and legal, which will consequently increase demand for precise geographical information.



4. GREEN DEAL: EU AGREES LAW TO FIGHT GLOBAL DEFORESTATION...

Biodiversity

Human pressure on the natural environment together with climate change give rise to challenges such as deforestation, pollution, overharvesting as well as a proliferation of invasive species, which in turn can lead to biodiversity loss. In response to the alarming rate of biodiversity loss worldwide, the UN has initiated the Decade on Ecosystem Restoration 2021–2030 to ensure countries deliver on their commitments to restore one billion hectares of land[5]. Still, most economic activities depend on and have an impact on biodiversity and ecosystem services, directly or indirectly. FIs need to understand their exposure to biodiversity-related financial risks and identify opportunities for mitigation. FIs can also enhance biodiversity through conservation or ecosystem restoration financing. The Dutch Central Bank and financial supervisor, De Nederlandsche Bank, became the first central bank to highlight biodiversity as a material financial risk[6]. Since 2022, French FIs have been required to disclose how they will identify, prioritise and manage climate and biodiversity risks [14]. In May 2020, the EU released a new Biodiversity Strategy for 2030, which includes legally binding targets for restoration of carbon-rich habitats. At the COP_{15} summit, the 30 by 30 target had been set with the aim of protecting 30 per cent of the world's land and sea by 2030 to, in turn, reduce biodiversity losses. However, it remains the case that precise universal metrics and KPIs for measurement do not yet exist.

For the time being, data are the biggest hurdle for investors trying to address biodiversity as measurable biodiversity-linked targets have not yet been defined [15]. In a survey, some 72% of 270 respondents said they have performed no assessments on their investments' impact on biodiversity whatsoever. While some banks and investment funds publish research papers and strategies, a standardised approach to biodiversity protection or even investments will probably still take years to emerge[7].
Even if FIs knew what they wanted to measure, the lack of biodiversity data would make it challenging to do so in practice [14]. Measuring biodiversity variables on the ground, such as species populations and ecosystem function and structure, is time and resource extensive. ALIGN (Aligning Accounting Approaches for Nature) and PBAF (Partnership for Biodiversity Accounting Financials), among others, propose measurements and related data [16].

Still, projects are already under way to better understand the impact of finance on nature and the related measurement solutions. The NGFS and INSPIRE, for example, have launched a joint research project on "Biodiversity and Financial Stability" to better understand the impact of finance on the provision of key ecosystem services as well as the consequences of biodiversity loss for financial stability [17]. The ENCORE tool (Exploring Natural Capital Opportunities, Risks and Exposure) developed by the Natural Capital Finance Alliance has been mentioned in various consultations, together with the Integrated Biodiversity Assessment Tool (IBAT). Besides the idea of protecting biodiversity, investors are becoming increasingly aware of the important material and systemic risk arising from their investments [19].

5. On international level, biodiversity is likewise being addressed by the SDGs, the Aichi targets and the post-2020 negotiations of the convention on Biological Diversity. The new EU Biodiversity Strategy 2030 stresses the need to integrate biodiversity considerations better into public and business decision-making.

6. A study concluded that Dutch financial institutions' portfolios consist of 36% of companies with high or very high dependency on one or more ecosystem services.

7. For example: WWF France and AXA recommendations for the... and BNP Paribas: SUSTAINABLE BY NATURE: OUR...

Nature-based Solutions

There is a growing interest to not only limit the negative impact on nature, but also to protect it and invest with a view to having a positive impact in **nature-based solutions.** These solutions aimed at having a positive impact on nature are notably supported by emerging technologies for stocktaking, location identification, impact assessments, and monitoring. Yet, current investments in nature-based solutions [8] amount to a mere US$133 billion annually [9]– about 0.10 per cent of global Gross Domestic Product, most of which comes from public sources (86%) [18]. In addition, carbon offsetting is developing as a commercial business, either on a voluntary basis or by means of emissions trading systems.

Of the public annual investments of US$115 billion, over a third is invested by national governments in the protection of biodiversity and landscapes. Private sector commitments are estimated at around US$18 billion per year. This includes activities such as biodiversity offsets, sustainable supply chains, private equity impact investment and smaller amounts from philanthropic and private foundations. However, such investments are perceived as high risk, low return and difficult to monitor. There is a general lack of "labelling, tracking, reporting and verifying" the state of finance for nature-based solutions.

New approaches are needed to improve data comparability and quality, as an input to future decision making (e.g. stock taking, location identification, impact assessments and monitoring). Continued growth in carbon offsetting as well as carbon credits, brought about by sustainability concerns as well as the rise of ETSs worldwide, can be expected to drive data demand from satellites, drones and low-flying aircraft. Blockchain can be one way to establish reliable linkages between national registry systems and the Paris Agreement. This includes token systems such as the Microsoft-backed InterWork Alliance initiative and the CBL Nature-Based Global Emissions Offset contract by AirCarbon and ClimaTrade. The World Bank through its Climate Warehouse also offers a public data layer connection to attached registry systems.

Estimated overview and classification of Nature-based solutions finance, UNEP, 2021

Domestic Government

Private Capital

Public ODA

8. A study concluded that Dutch financial institutions' portfolios consist of 36% of companies with high or very high dependency on one or more ecosystem services. WCC-2016-RES-069-EN DEFINING NATURE...

9. Estimates do not cover all types of nature-based solutions, with notably those in the marine environment excluded, despite their importance.

Bankable solutions and Payment for Ecosystem Services

The market is estimated to stand at US$51m annually. Governments and Multilateral Development Banks (MDBs) are looking at how to incentivise landowners by payments to protect watersheds, conserve biodiversity or restore natural carbon through forests, replanting trees or sustainable agriculture, but also infrastructure resilience, especially in coastal areas. Water trading services, for their part, are focused on setting up schemes to enhance water quality or availability.

The EIB, for example, manages the Natural Capital Financing Facility supporting conservation and bankable nature-based solution projects as an alternative to grants. Such projects may focus on sustainable forestry, sustainable agriculture (e.g. pollinator-friendly agriculture), sustainable aquaculture, ecotourism (e.g. sustainable wild fishing), carbon sequestration or green infrastructure[10]. In addition to the EIB, other MDBs, as well as the World Wide Fund For Nature (WWF) are looking at bankable nature-based solutions that can generate positive impacts on nature and positive financial return. The discussion on bankable nature-based solutions and ecosystem services is far from new, but has garnered renewed attention in recent years. Moreover, since the 1990s, nature for debt swaps have...[11]. While in recent times only a few transactions have been carried out worldwide, debt burden and recovery plans in a post-COVID world could trigger fresh interest in joint nature protection and the related reporting needs to investors.

Wealth Accounts and Sovereign Debt

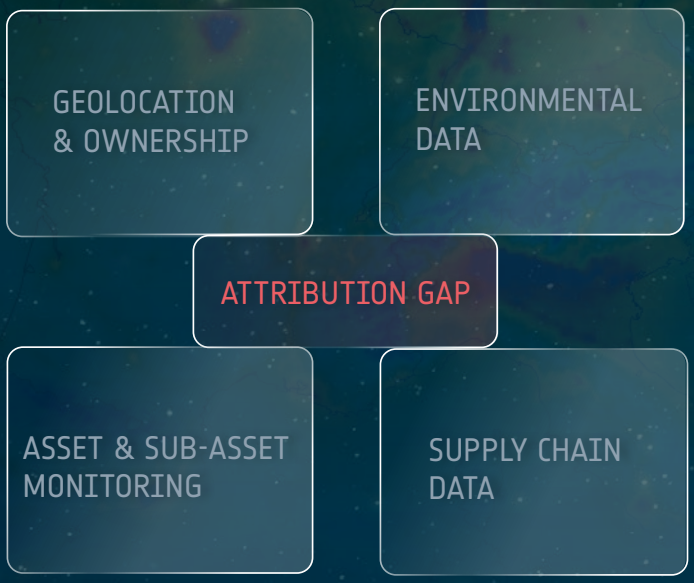
The World Bank, together with other stakeholders, has highlighted the fact that the lack of integration of natural capital in public national wealth accounts fails to reflect national wealth fully, but also the associated risks [19]. In March 2021, the United Nations Statistical Commission adopted SEEA Ecosystem Accounting (SEEA EA), a new framework that includes the contributions of nature when measuring economic prosperity and human well-being, as well as ensuring that natural capital, forests, wetlands and other ecosystems are recognised in economic reporting[12]. In "Making Peace with Nature", the UN states how a three-fold increase in the extraction of natural resources has fuelled economic growth over the last 50 years [20]. For now, more than 34 countries are in the process of compiling ecosystem accounts on an experimental basis. While the new framework might motivate more countries to implement similar accounting systems, the UN acknowledges that "a significant number of countries will require assistance and additional resources for statistical data collection".

Dependency on nature to generate economic wealth is peculiarly high in developing countries. In fact, natural capital constitutes almost half of the wealth in low-income countries and more than a quarter in lower- and middle-income countries. Nevertheless, investors consider mainly political and social factors in their risk profile when assessing sovereign debt [21]. A recent report by the WWF and Investec Asset Finance has shown how sovereign debt investments fail to comprehensively integrate environmental issues, despite the reliance on natural capital for many key industries. The report argues that advances in geospatial data and satellite imagery could help sovereign debt investors better assess and manage environmental risks while also supporting research, security valuation and portfolio management. The UN Principles for Responsible Investment have established guidelines and collected a sample of freely available environmental data sources to integrate ESG in sovereign debt analysis. The World Bank's sovereign ESG portal is already working with various geospatial data inputs with the support of ESA[13].

10. The EIB Paper "Investing in Nature: Financing conservation and nature-based solutions" highlights some of these examples in more detail.
11. The Seychelles were burdened by a heavy sovereign debt load and rising sea levels. In a PPP, Nature Conservatory Fund and a group of philanthropists restructured the existing debt to implement the Marine Spatial Plan and conserve 40,000km of marine area.
12. SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING—ECOSYSTEM...
13. ENVIRONMENTAL, SOCIAL, AND GOVERNANCE DATA... with support from the EO Clinic "Natural Wealth and Sovereign Risk: NATURAL WEALTH AND SOVEREIGN RISK

Green Finance Needs

Most of the relevant needs associated to ESG and nature-based solutions revolve around questions of geolocation and ownership, asset and sub-asset monitoring, reliable environmental data and supply chain transparency.



Geolocation and ownership: Asset data and attributes are available commercially for a few sectors and only to a limited degree (e.g. mining, shipping, oil & gas, power plants, real estate). Relevant attributes of assets can be age, capacity, ownership and geospatial coordinates. It is especially the lack of geospatial information in credit and investment deals, as well as their disclosure, that is a major obstacle to producing scalable solutions, but also to closing the attribution gap to environmental change. There are no general systems in place allowing for asset data exchange between actors [22]. Business intelligence providers hold databases on company tree level and universal IDs exist to a certain degree (e.g. GLEIF Legal Entity Identifier - LEI or Refinitiv), yet open source solutions remain limited [22].

Asset and sub-asset monitoring: Companies will need new Internet of Things (IoT) connectivity solutions and digital platforms to understand the environmental impact of their activities ranging from air and water pollution to landscape changes and biodiversity. An understanding of point-in-time performance of an exposure against a transition pathway as well as monitoring of the impact of adaptation and mitigation measures is needed [23]. Mechanisms for verifying and auditing climate-related financial disclosures are essential to making data reliable and comparable [23]. Air pollution and in particular methane emission monitoring and tracking, as well as deforestation, are of the greatest interest at the present time. During the COVID-19 crisis, on-site inspections for due diligence or monitoring have been limited.

Environmental data: Consistent, frequent, accessible and inexpensive climate and environmental data in high resolution is needed as well as converting qualitative information into quantitative data points. This also includes the proximity to cultural or natural sites or protected areas such as rivers, wetlands, forests, or endangered species and their status and development [22]. Reliable, cost-efficient location identification, implementation, monitoring and verification is needed for nature-based solutions. Regional and national administrators require reliable, up-to-date data for statistical purposes.

Supply chain transparency: The lack of geolocation data and limited company disclosures make collecting supply chain data a challenge. This is relevant when it comes to emissions across all industries, but is also highly relevant for commodity value chains, and especially for deforestation. Few general national or sector databases exist, but those that do are not connected, nor do they specify environmental impact. Greater specificity, supply-chain tracking, interconnectivity and models for risk probabilities are needed [22].

Space Added Value and Synergies

Space infrastructure can look back on decades of successful climate and environmental data collection, monitoring and insights. The Oxford Sustainable Finance Group at the University of Oxford and activities by the World Bank and WWF provide the most advanced examples[14]. It is also true for leveraging satellite data to create asset-level datasets and carry out climate risk analysis[15]. International financial institutions and rating agencies integrate spatial ESG data with the aim of gaining better data, understanding correlations, and monitoring project success. The Spatial Finance Initiative, which aims to integrate geospatial data and analysis into financial theory and practice, sees considerable growth potential in the ESG data, environmental and nature and biodiversity markets – in comparison to more mature spatial finance solutions.

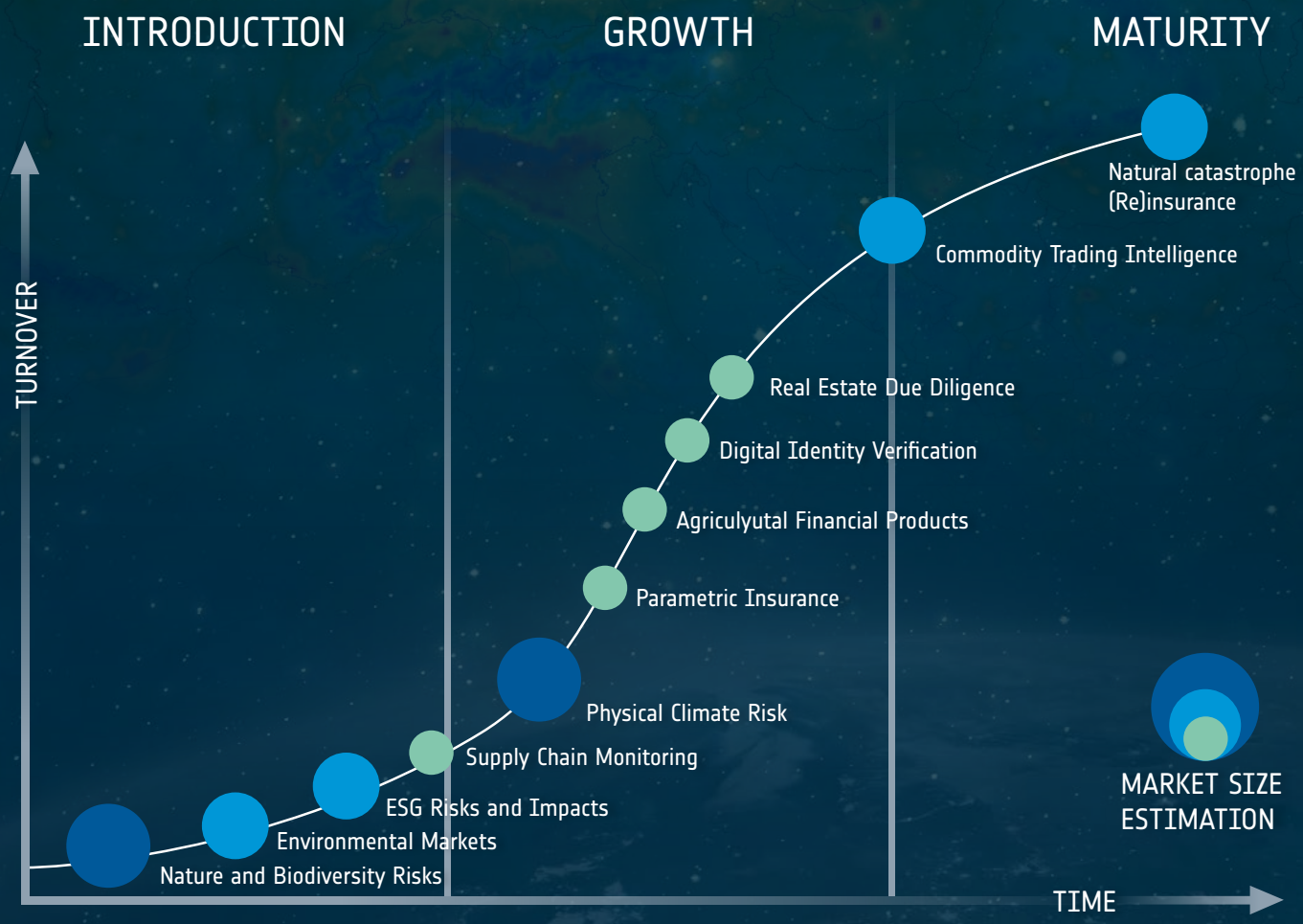


Figure 6: Maturity and addressable market size for spacial finance solutions, Spatial Finance Initiative, 2021

14. Catapult collected main sustainable finance market sources with links to space added value: SUSTAINABLE FINANCE MARKET INTELLIGENCE...

15. See for details "Climate risk analysis from space: remote sensing, machine learning, and the future of measuring climate-related risk": CLIMATE RISK ANALYSIS FROM SPACE...

As set out in ESA Agenda 2025, the European Space Agency is focusing its efforts more than ever on supporting green, sustainable solutions as well as on leveraging public and commercial space infrastructure and knowledge. Some of the use cases highlighted have already been addressed by ESA[16], often in the framework of cooperation with MDBs[17], but also with commercial stakeholders. MDBs operate with the goal of creating positive impacts and work under specific monitoring and evaluation guidelines[18]. The ESA Sustainability Office provides support to the World Bank's Sovereign ESG Data Portal[19] through the ESA Global Development Programme. Experience from nature-based solutions can also be transferred to further address emerging commercial needs.

The added value of spatial data lies in its high frequency, quality, comparability, consistency and scalability as highlighted by the Spatial Finance report of the World Bank and WWF [22]. Space companies have highlighted the momentum of an emerging structural integration with the finance sector, beyond pilot and project-based work. Indeed, space infrastructure can contribute to filling ESG data gaps, specifically with regard to environmental ESG parameters and nature-based solutions and ensure connectivity of local sensors on asset or sub-asset level (and integration with 5G/6G) as well as geolocation of assets. Existing public infrastructure, such as Copernicus and Galileo, are building the basis of derived commercial applications and services and are being increasingly complemented by private constellations.

Space companies fill existing market gaps and provide solutions for corporates and financial institutions to better understand and manage their environmental impact and reporting on sub-asset, asset and corporate level, but also along the supply chain. European Earth observation and data processing companies already provide considerable value to the further development of the sector. A snapshot of some of the relevant actors can be seen in the figure below.

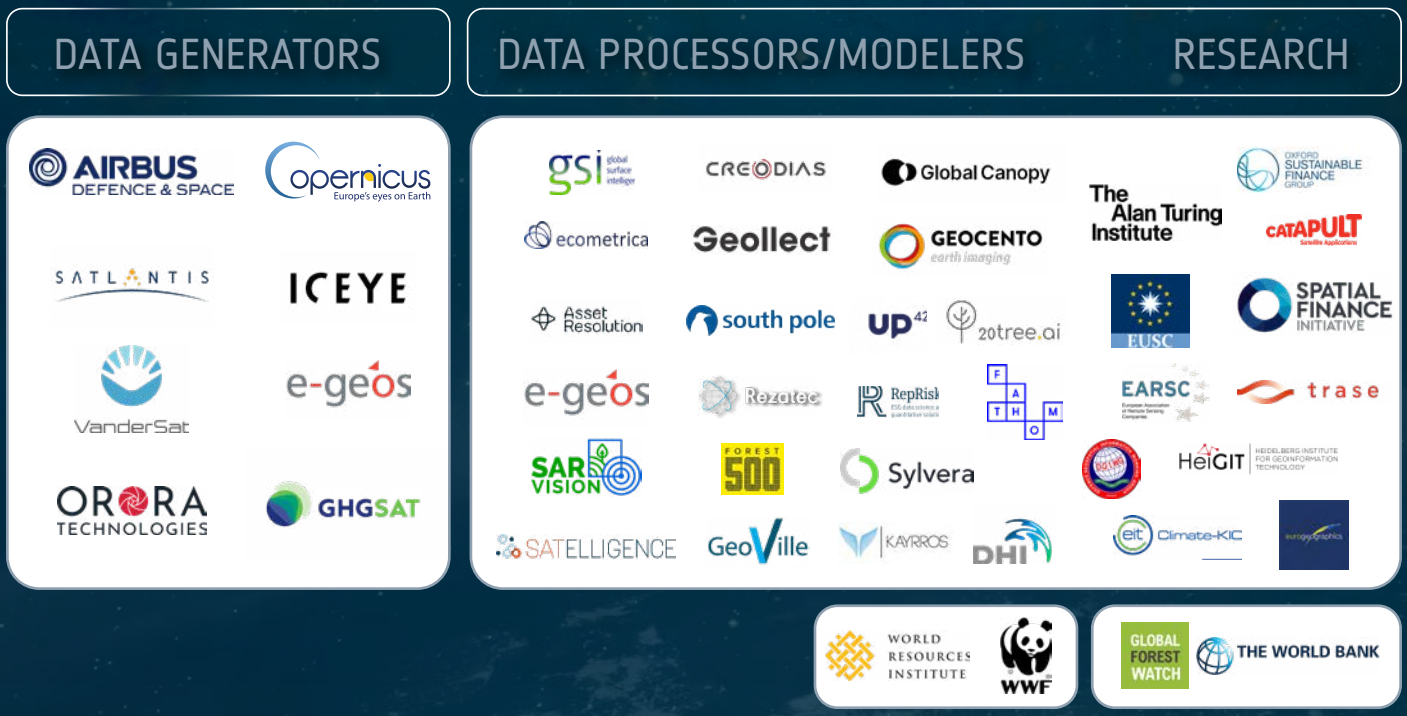


Figure 7: Examples of EO actors providing value to the Green Finance ecosystem.

16. See Space For Green Applications: CLIMATE RISK ANALYSIS FROM SPACE: REMOTE SENSING...
17. An early publication was already focusing on Green Growth projects as early as 2013 (Green Growth: Earth observation for international development projects): ENVIRONMENT, CLIMATE CHANGE AND GREEN...
18. Examples of use cases in the report: ADOPTION AND IMPACT OF...
19. See: THE WORLD BANK CURATES AND MAINTAINS A WIDE...

GHG observations have raised public awareness of the added value of satellites as exemplified by the RACE platform. For the time being, it is public satellites that generate the greatest added value for high-emission areas such as large cities, but the need for point source emission monitoring is gaining attention globally (e.g., large power stations, refineries or landfill) [24]. Considerable attention has also been given to Bluefield's, Kayrros' or GHGSat's[20] identification[21] of methane leakages focusing on oil and gas and power plants. Yet, general stakeholders, including the finance industry, suffer from the lack of systematic asset-level GHG data collection, monitoring and verification. Remote sensing, together with local sensors, can help secure better data at higher frequency. With increasing sensor capabilities, computing power and machine learning, assets can be tagged and identified together with their characteristics [25]. Integration with existing IoT/in-situ sensors and systems and the related connectivity via satellite for data transmission can add value, especially in remote areas.

Asset-level emissions can be monitored directly or indirectly. Direct measurement by satellite is currently only feasible for a few use cases (in remote areas, for example) using commercial high-resolution payloads. Alternatively, asset characteristics identified through machine learning can be used, which offers an indirect method for completing existing or building new data sets (in combination with accurate land use characterisation and change detection). Commercial high-resolution satellites are able to monitor, through direct measurements, asset-level emissions.

Sentinel-5P monitors methane (CH4), formaldehyde (HCOH), aerosol, carbon monoxide (CO), nitrogen dioxide (NO2) and sulphur dioxide (SO2) in the atmosphere. Nevertheless, spatial resolutions of 7 km × 5.5 km or more are not sufficient for asset-level data (or only in remote areas). Hence, Sentinel-5P is currently providing a platform to guide commercial satellites, such as GHGSat satellites[22], to pinpoint specific sources in higher resolutions. Figure 7 gives an overview of current and planned greenhouse gas monitoring missions.

The challenges outlined support the creation of new partnerships, especially Public Private Partnerships. The International Methane Emissions Observatory 2022 highlights the role of UNEP in helping oil and gas companies across the world measure and reduce their methane emissions. Another example is the partnership between the State of California, NASA and Michael Bloomberg, which launched the Carbon Mapper targeting large GHG emissions from individual sources[23].

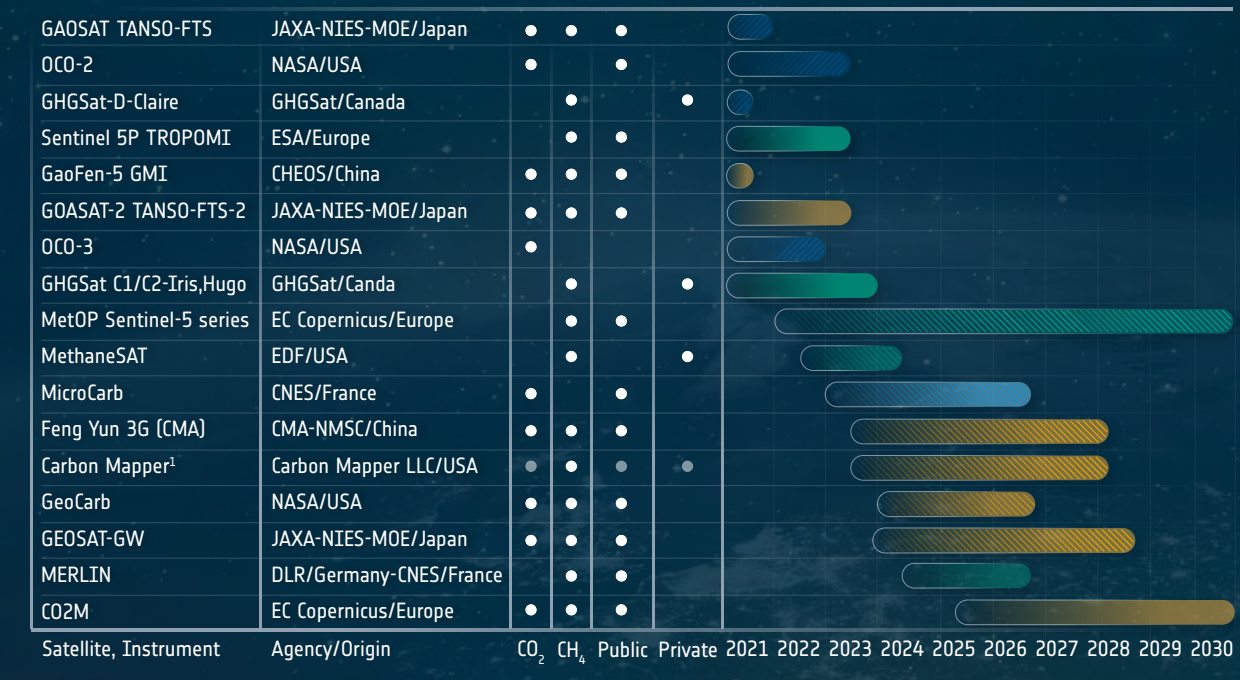


Figure 8: Greenhouse Gas Monitoring Missions, Spacenews, 2021

20. GHGSat has set up SPECTRA a global emissions intelligence platform to support both high-resolution data and macro datasets. It joined the ESA Third Party Mission in May 2022.
21. See for example: LARGE METHANE LEAK DETECTED OVER...
    or: LARGE METHANE CLOUD DETECTED OVER...
    Since 2020, Kayrros is also feeding data on large scale methane leaks into the International Engery Agency's Methane Tracker.
22. GHGSAT CONFIRMS SUCCESSFUL LAUNCH OF THIRD...
23. CALIFORNIA, NASA PARTNER TO LAUNCH METHANE-TRACKING...

Data will be shared publicly, but companies that own and operate emitting infrastructure can pay to obtain access to the data sooner, allowing them to address leaks. Also, GHGSat and Shell formed a partnership to detect methane emissions in a year-long programme[24]. More such partnerships can be expected to be formed in the future.

When it comes to **deforestation**, a number of space-based solutions have emerged. Major studies on deforestation such as the recent study by the World Resources Institute [25] built their analysis on various satellite-based data sources. ESA, together with the Committee for Earth Observation Satellites (CEOS), has supported initiatives such as the Carbon Tracking System, the Global Forest Observing Initiative and "Reduced Emissions from Deforestation and Forest Degradation" (REDD) activities. Successful pilot projects have, for example, integrated satellite data with other communication systems to set up local warning systems. Under increasing regulatory pressure, especially in commodity sectors, commercial, demand for such solutions will increase still further. European companies like Satelligence have developed services using Sentinel-1 and Sentinel-2 data, while Airbus and the Earthworm Foundation are offering a monitoring service called Starling to identify high-risk areas[26].

Presently, there is still a lack of clarity about standards associated with biodiversity loss, the sectors and industrial processes most affected, and the most appropriate approaches with which to measure biodiversity-related risks on behalf of the finance sector. Complementing costly on-the-ground measurements, the use of EO data to map and monitor biodiversity through alternative proxy insights is a scalable and economical solution, as shown by the WWF and Maxar in the recent report "The Biodiversity Data Puzzle" [31]. The impact of an asset can be simplified into direct (habitat clearance) and indirect impacts. Also the Group on Earth Observations Biodiversity Observation Network (GEO BON) proposed a framework of essential biodiversity variables (EBVs) [27]. The United Nations Biodiversity Lab likewise uses spatial data for biodiversity. Further awareness-raising and needs identification are required in order to include insights into ongoing ESG-related biodiversity frameworks and regulations.

Satellites can set up baselines to identify new projects, but also to support the monitoring and reporting of the development and conservation of **nature-based solutions**, especially in the framework of climate adaption projects and carbon offset monitoring. Tech innovations are emerging to tackle the lack of monitoring such as the Global Mangrove Trust, Pachama, or the UK-based Sylvera (which so far has raised close to US$40m), using various technologies, satellite data included among them. With the increase in carbon offsetting and related digital technologies including blockchain, new applications are beginning to emerge. Geospatial information is also key to obtaining natural wealth information on the country, not only project or regional level. This is relevant for national accounting, climate-related project selection and financial applications to climate funds, as well as sovereign debt. There is a need for long-term data sets to track changes in ecosystem services. Through the GDA programme, ESA is also supporting development banks in the development of remote sensed monitoring, reporting and verification (MRV) systems for land use emissions reduction programmes.

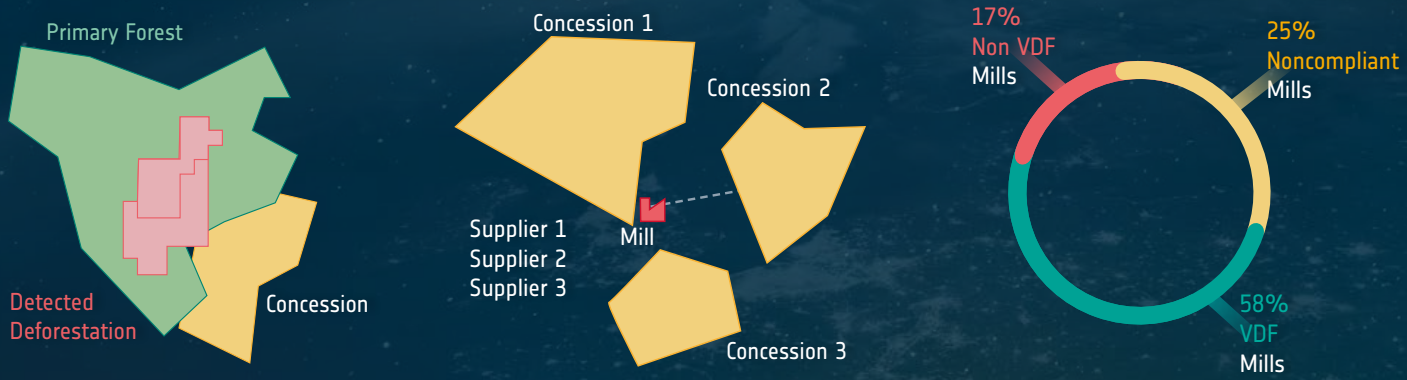


Figure 9: Satelligence provides services to prevent deforestration events, identify high risk sourcing areas, and measure progress and trends, Satelligence [27]

24. SHELL RECOGNISED FOR GOLD STANDARD METHANE...
25. Goldman, E., M.J. Weisse, N. Harris, and M. Schneider. 2020. "Estimating the Role of Seven Commodities in Agriculture-Linked Deforestation: Oil Palm, Soy, Cattle, Wood Fiber, Cocoa, Coffee, and Rubber." Technical Note. Washington, DC: World Resources Institute. Available online at: ESTIMATING THE ROLE OF SEVEN COMMODITIES IN AGRICULTURE...
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Conclusion

A Green Finance Ecosystem is emerging and tighter regulations are driving commercial demand for ESG data, especially with regard to air pollution, deforestation and biodiversity. Data collection, monitoring and verification remains a challenge and approaches are currently dominated by indirect measurements and estimations. New policy measures and regulations across industries increase the need for worldwide, consistent, reliable and fact-based data. Corporates, investors and governments, therefore, require enabling data and tools in order to understand, plan and monitor risks at project, portfolio or even system level – as well as their impact on the environment.

In addition, with the likely relative shift from traditional Official Development Assistance projects to innovative climate financing, higher project volumes and more private stakeholders could be reached. Moreover, public actors, from MDBs to national promotional banks, are pushing for increasing standards and green recovery with measurables results. On national level, further support opportunities might exist for the assessment of national natural wealth accounts, assessment of nationally determined contributions as well as related financing (sovereign and climate finance).

A systematic uptake of spatial data and solutions can be expected to occur driven by increasing interest from the financial community. In this context, ESA, with a considerable pipeline in supporting digital and green projects, can offer support to European companies and institutions worldwide. Programmes and activities such as InCubed, TIA Bass, FutureEO and Global Development Assistance are already leveraging space infrastructure to address the emerging green finance market.

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ACRONYMS

CDP	Carbon Disclosure Project
CFA	Charted Financial Analyst
CO	Carbon monoxide
EBV	Essential biodiversity variables
ESG	Environmental, Social and Governance
ESA	European Space Agency
ETS	Emissions Trading System
EU	European Union
FI	Financial Institution
GEO BON	Group on Earth Observations Biodiversity Observation Network
GHG	Greenhouse Gases
HCOH	Formaldehyde
IOT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ISIN	International Securities Identification Number
LEI	Legal Entity Identifier
MDB	Multilateral Development Bank
NGFS	Network for Greening the Financial System
NO2	Nitrogen dioxide
PACTA	Paris Agreement Capital Transition Assessment
PPP	Public Private Partnership
SDG	Sustainable Development Goals
SFDR	Sustainable Finance Disclosure Regulations
TCFD	Task Force on Climate-related Financial Disclosures
SO2	Sulphur Dioxide
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WRI	World Resources Institute
WWF	World Wide Fund For Nature

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