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STATE AND TRENDS OF SPATIAL FINANCE 2023

Fundamental Building Blocks for Transparency and Accountability in Green Finance

ABOUT THIS REPORT

This report is the Spatial Finance Initiative's second overview report of spatial finance solutions and trends. It provides an update of both technical and market developments since the 2021 report, a deep dive into three application areas with significant growth potential, and an overview of trends that will shape the future of spatial finance.

The information presented here is drawn from publicly available sources and builds upon the extensive experience of the Spatial Finance Initiative across this topic. The report by no means claims to cover all the available spatial finance offerings or potential applications but aims to show the breadth of solutions and opportunities available for applications in finance.

The report will be of relevance to audiences across both the finance and geospatial communities. To practitioners at different levels within financial institutions, financial sector (data) intermediaries and professions. As well as to businesses, entrepreneurs and researchers across the climate and environmental science community and stakeholders across government, civil society and corporations.

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KEY TAKEAWAYS

- Technologies for capturing and processing geospatial data continue to improve. Satellites are being launched that can capture heat signatures, greenhouse gas emission concentrations, and more. Applications leveraging artificial intelligence are transforming these developments into near-real time insights at a global scale, e.g. for modelling emissions or land use changes.

- Policies and regulations around climate risk disclosures are driving demand for geospatial data and analytics. At the same time governments, corporates and financial institutions alike are setting net zero targets or committing to tackling methane emissions, deforestation or climate change adaptation — areas where spatial finance solutions can fill data gaps and bring transparency.

- Solutions for assessing physical climate risks, monitoring outcomes in environmental markets, or understanding nature-related risks and impacts, are some of the fastest growing application areas in spatial finance. While these are all sector agnostic solutions, opportunities remain for sector specific geospatial solutions to be translated for financial sector use.

- Trends in green finance indicate strong potential for new and more spatial finance applications. These include the increasing demand for integrity in green finance products and claims, financial institutions embracing the complexity of sustainability issues, and the need for more effective and impactful investor engagement.

TRENDS IN GREEN FINANCE INDICATE STRONG POTENTIAL FOR NEW AND MORE SPATIAL FINANCE APPLICATIONS

- Asset (location) data is a fundamental building block for many current and future spatial finance applications but is not readily available. Despite growing availability of sectoral asset datasets from third party providers, financial institutions struggle with collecting or accessing this information in a format useful for climate and environmental analysis. Access to asset data will need to improve to realise the full potential of spatial finance in bringing transparency and accountability to green finance.

SPATIAL FINANCE DEFINITION AND CONTEXT

What is spatial finance?

"Spatial finance" is the integration of geospatial data and analysis into financial theory and practice. Advances in earth observation, remote sensing and artificial intelligence can transform the availability of information in our financial system, and change how risks, opportunities and impacts are measured and managed by the financial system. By incorporating geospatial information related to specific locations and their environmental and socio-economic context into financial decision-making, spatial finance offers an opportunity to enhance transparency within the financial system for financial institutions, regulators and civil society alike.
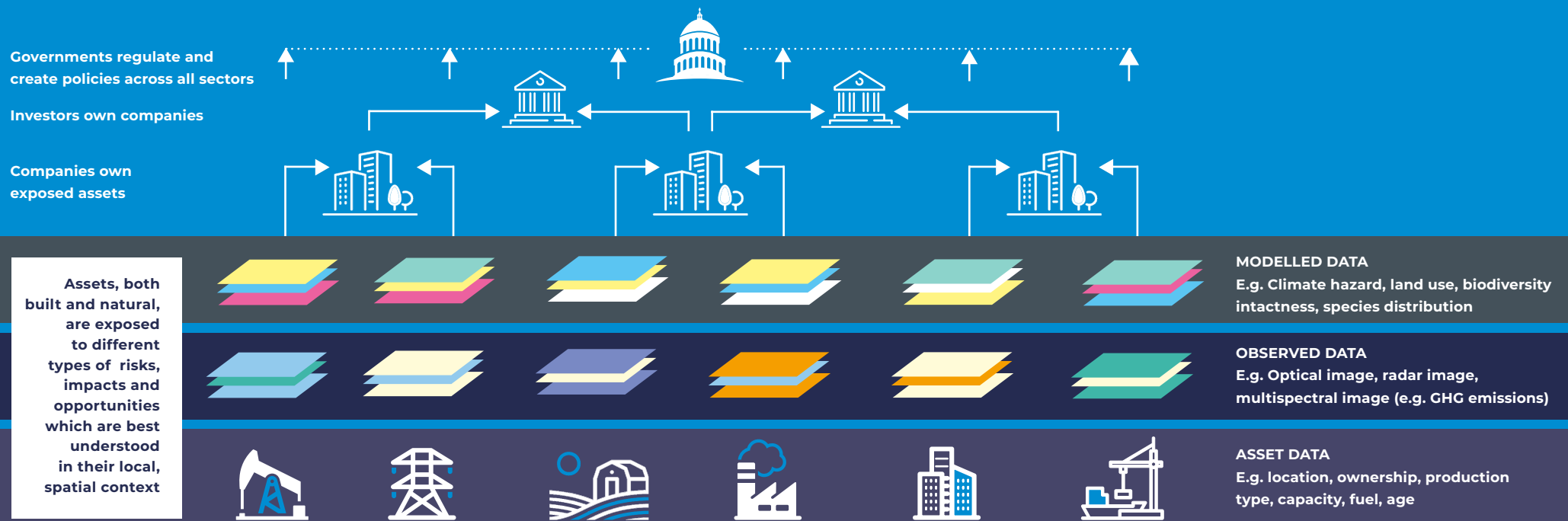
Spatial finance building blocks

Inherently, spatial finance is about analysing and understanding economic activities in their geographical and socio-economic context. A spatial finance approach allows us to build a bottom-up picture of a company, sector or portfolio starting from its physical assets and supply chains. We distinguish three types of asset-level datasets that can inform a spatial finance analysis:

- **Asset data**: Information about physical assets, either built or natural, linking exact location and basic operational characteristics (e.g. capacity, production type, age) with ownership information. This data is typically static with infrequent changes based on one-off decisions such as upgrading or selling off assets.

- **Observational data:** Information about the state of the physical environment or changes therein. These may be caused by the operations of a physical asset, or by exposing the asset to environmental risks or opportunities. We distinguish:

  - **Observed data:** Information about the state of the environment that is directly observed or measured, typically by sensors on the ground or by platforms such as satellites or UAVs. This data is inherently location specific and is high dynamic as it can change frequently (e.g. pollution concentrations, water availability, species DNA presence).

  - **Modelled data:** Information about the state of the environment or changes therein that cannot be directly measured but is modelled using a combination of observed data points and other datasets or assumptions. This can provide information about a much wider set of risk, impact and opportunity indicators as well as forecasts or simulations (e.g. greenhouse gas emission rates, heat stress, ecosystem intactness).

SPATIAL FINANCE PROVIDES AN OPPORTUNITY TO ENHANCE TRANSPARENCY WITHIN THE FINANCIAL SYSTEM

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Governments regulate and create policies across all sectors

Investors own companies

Companies own exposed assets

Assets, both built and natural, are exposed to different types of risks, impacts and opportunities which are best understood in their local, spatial context

MODELLED DATA
E.g. Climate hazard, land use, biodiversity intactness, species distribution

OBSERVED DATA
E.g. Optical image, radar image, multispectral image (e.g. GHG emissions)

ASSET DATA
E.g. location, ownership, production type, capacity, fuel, age

Geospatial observational datasets, particularly from satellite earth observation instruments, have inherent qualities that make them a highly relevant data source for financial institutions, complementing corporate disclosures and other data sources:

- Granularity of insights at the asset level allowing for bottom-up analysis

- Objectivity, as data is collected by instruments owned by third parties

- Comparability over time and across locations from data collected by the same instrument

- Timeliness, as data can be captured every few weeks, days or even hours

- Scalability from continuous improvements in processing and collection technologies

TECHNOLOGY ADVANCEMENTS
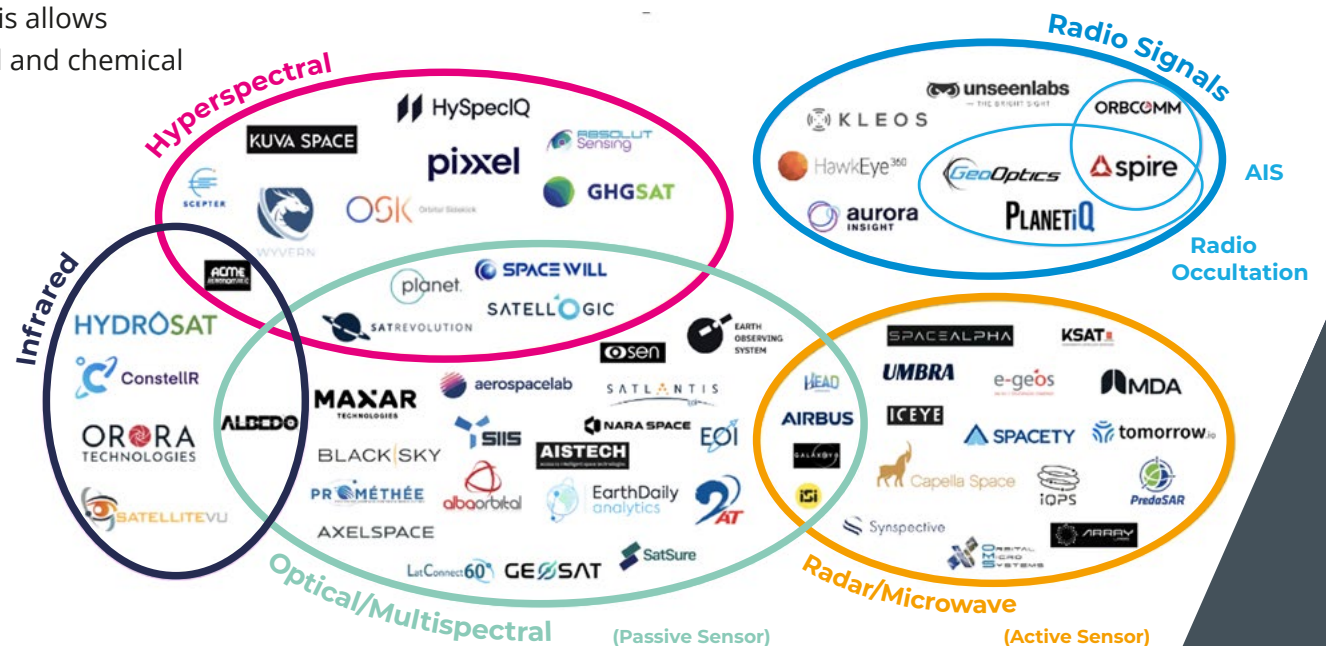
Earth observation data

Spatial Finance is becoming an increasingly relevant tool for the financial services sector, due to rapid technological developments in both the collection and processing of geospatial data.

While earth observation data from optical, and to some degree radar, instruments is commonly used within spatial finance applications (for instance across the climate risk solution value chain), new sensor types are coming online that offer additional insights:

- Hyperspectral earth observation satellites can capture 10s-100s of different wavelength bands, compared to 3-8 bands captured by traditional optical and multispectral satellites. This allows these satellites to capture more detailed biophysical and chemical properties of our planet, distinguishing soil and vegetation types, and other surface features. For example, ESA's Copernicus Hyperspectral Imaging Mission for the Environment and Satellogic's hyperspectral constellation provide data relevant for monitoring sustainable agricultural practices, biodiversity assessments or water quality.

- A subset of these satellites specialises in capturing greenhouse gas emission concentration data. For example, ESA's Sentinel 5P or the GHGSat constellation have been capturing methane, N2O, S2O, etc. for several years now. New satellites from MethaneSat and

CarbonMapper, expected to launch in 2023, will generate even more methane and CO2 point-source emission data, which can be used to attribute observed emissions to individual assets and operators.

- Infrared earth observation satellites capture data in the (thermal) infrared spectrum. Start-ups across Europe and the US have launched or are about to launch infrared satellites. For example, Constellr satellites capture land surface temperature data for agriculture and water management applications and SatelliteVu focuses on thermal emissions from buildings and industrial facilities, while Orora Technologies provides wildfire detection and monitoring capabilities.

Commercial earth observation data acquisition landscape in 2022. Source: TerraWatch Space
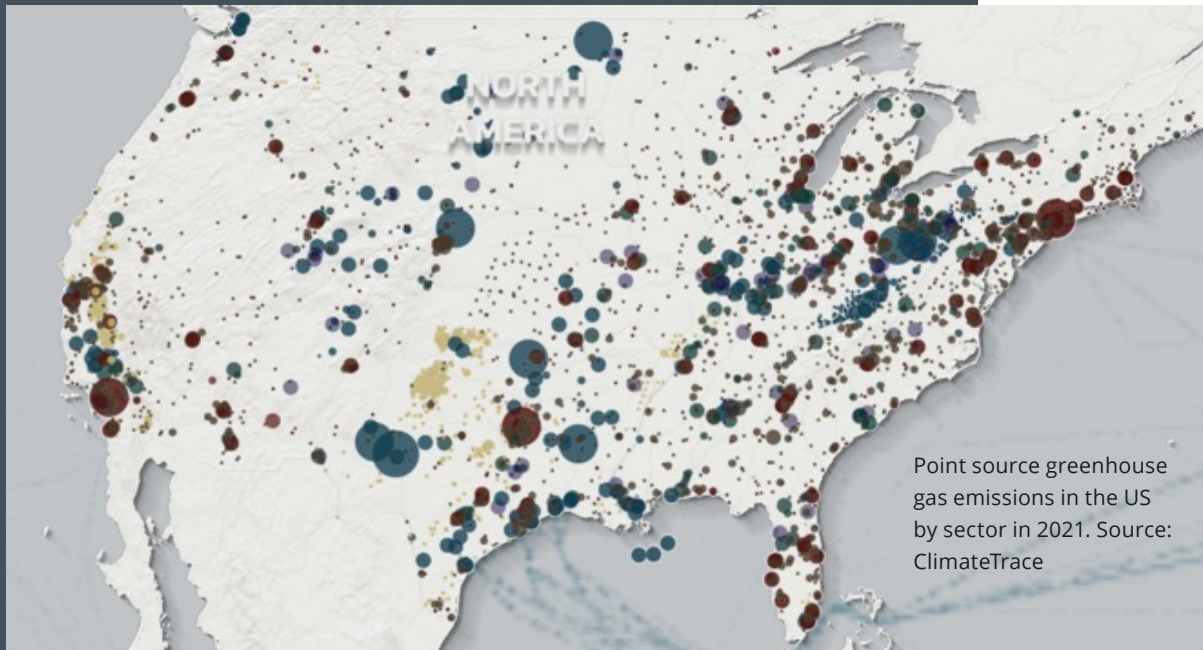
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Point source greenhouse gas emissions in the US by sector in 2021. Source: ClimateTrace

ADVANCES IN ARTIFICIAL INTELLIGENCE ALLOW THESE VAST AMOUNTS OF EARTH OBSERVATION DATA TO BE PROCESSED AND ANALYSED A LOT FASTER AND IN HIGHER QUANTITIES

Artificial intelligence

Advances in artificial intelligence allow these vast amounts of earth observation data to be processed and analysed a lot faster and in higher quantities. We've seen some exciting open source applications come online or be announced in this area in the last year, including:

- **ClimateTrace**, a global non-profit coalition that uses satellite imagery and artificial intelligence to model greenhouse gas emissions at the individual asset level for 10 sectors and 79,815 facilities around the world. Their emissions data and methodologies are made freely available and provide an independent inventory of global greenhouse gas emissions and trends.

- **Dynamic World**, developed by Google and the World Resources Institute, generates near real-time global land cover datasets based on openly available satellite imagery from the European Space Agency. It generates 9 different land cover classes at a 10m resolution and is updated every couple of days depending on the location.

- **Global Renewables Watch**, developed by Microsoft, Planet and the Nature Conservancy, will map all utility-scale solar and wind installations globally, allowing users to track deployments over time, understand trends and monitor clean energy transition progress.

MARKET DEVELOPMENTS

Policies and commitments

A significant driver of demand for Spatial Finance applications are developments within "green finance" and the growing need to incorporate a wide set of climate and environmental risks, impacts and opportunities into financial decision-making. As many environmental issues are inherently location-specific, geospatial analysis and insights are needed to understand and integrate them appropriately. On top of consumer pressure and client demand for more sustainable financial products, we've seen announcements of climate risk disclosures becoming mandatory for large corporates and financial institutions (e.g. US Securities and Exchange Commission proposed rule for climate-relate disclosures), as well as numerous climate action commitments from companies and governments, particularly around the international climate conferences such as COP26/COP27 (e.g. Net Zero Tracker aggregates information on net zero targets around the world).

At COP26 in Glasgow there was a strong emphasis on the role that private (green) finance can play in driving climate action. It saw announcements by financial institutions (e.g. Glasgow Financial Alliance for Net Zero committing their members' capital to USD 130 trillion to achieving net zero by 2050), governments (e.g. the UK pledge to be the world's first net zero-aligned financial centre with an emphasis on mandatory transition plans for listed companies and financial institutions) and standard setters (e.g. International Financial Reporting Standards setting up a new International Sustainability Standards Board to develop global reporting standards on climate and sustainability issues.)

On top of these green finance commitments at COP26, more specific areas of climate action gained momentum:

- The Global Methane Pledge saw over 100 countries agree to reduce global methane emissions by 2030 by at least 30% from 2020 levels.

- Forests saw serious plans under the Glasgow Leaders' Declaration on Forests and Land Use to halt and reverse forest loss, as well as the Global Forest Finance Pledge to invest $12bn for forest-related finance.

- Finally, momentum was built around climate adaptation and resilience, with adaptation (finance) pledges from numerous countries.

While many of these commitments were made by countries and policymakers, there are opportunities for financial institutions to support their clients and investees in implementing these goals. To avoid incurring financial and reputational risks where insufficient progress is made or voluntary government commitments become legislation.
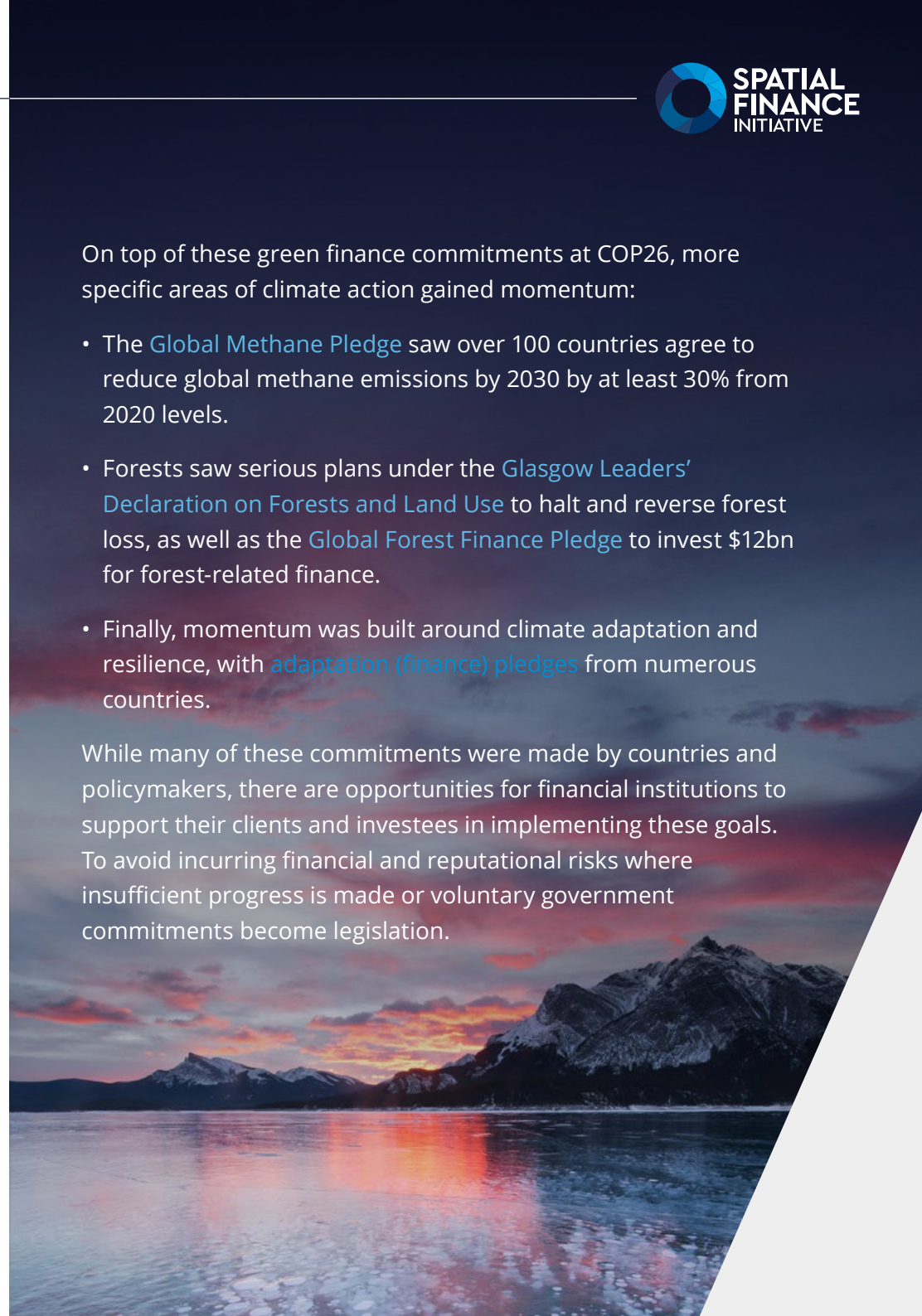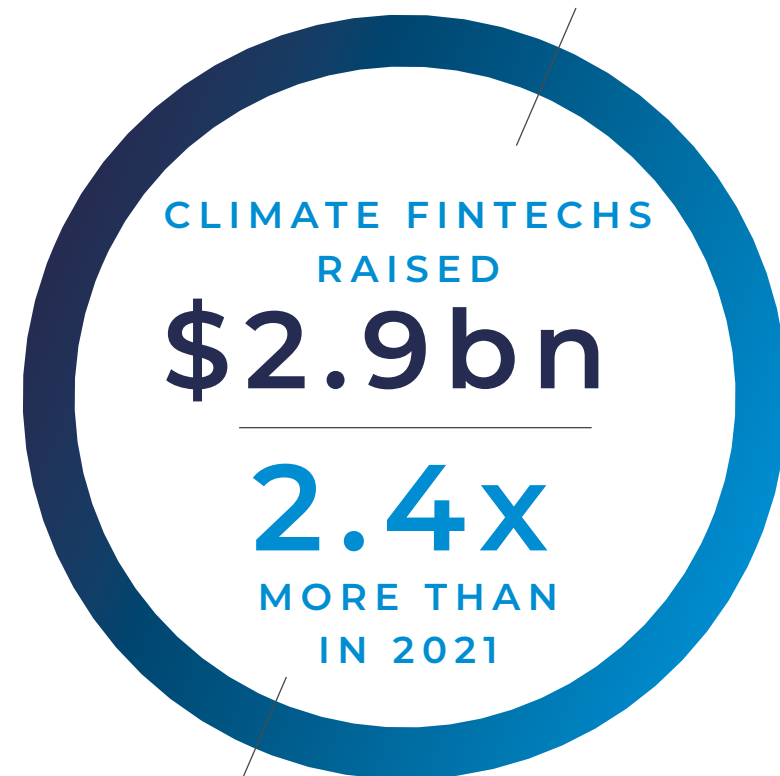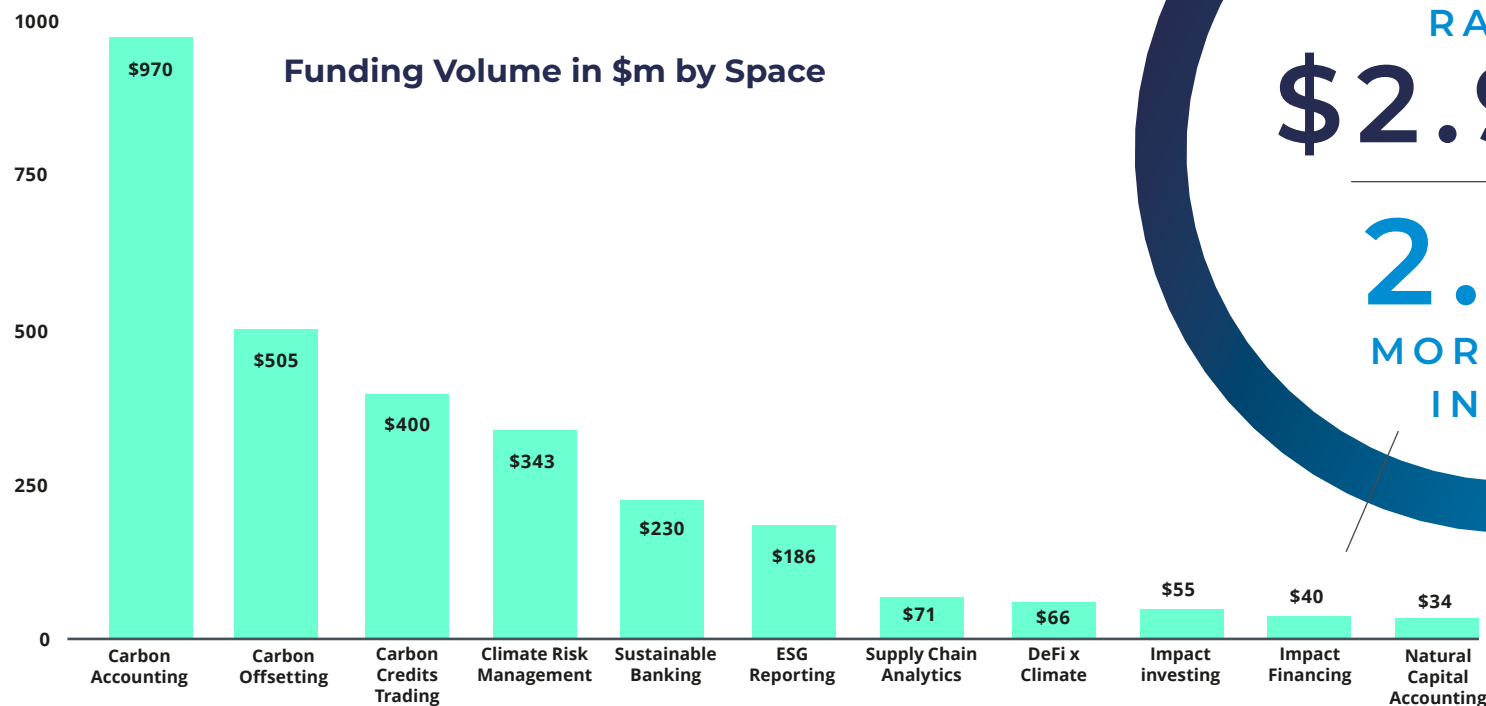
Financial data market trends

In parallel, some of the world's largest financial data and service providers continue to acquire or partner with specialist climate and environmental data and analytics companies. While a first wave of ESG data provider acquisitions targeted solutions based on company disclosures, a second wave of acquisitions and partnerships is now targeting more specialist and scientific solutions.

- Moody's acquired Risk Management Solutions, a global provider of climate and natural disaster risk modelling and analytics. S&P Global acquired The Climate Service, a provider of quantified climate risk analytics for corporates, governments and investors. Moody's also acquired a minority stake in Fathom, a specialist global flood modelling company.

- GHGSat's deal with Bloomberg allows it to provide "methane emissions risk predictions" to the financial services sector through Bloomberg platforms. A strategic partnership between Planet and Moody's sees both companies collaborate on ESG, Know-Your-Customer, supply chain and commercial real estate products through real-time on-the ground insights. Partnerships between Jupiter Intelligence and consultancy firms BCG and Aon combine Jupiter's data with the firms' advisory services to offer tailored climate resilience insights to clients. RepRisk is partnering with the Integrated Biodiversity Assessment Tool (IBAT) Alliance to deliver geospatial biodiversity risk assessments through its RepRisk ESG Risk Platform. Accenture is collaborating with Planet on AI powered geospatial intelligence tools for sustainability, traceability and climate risk solutions.

SPATIAL FINANCE STATE AND TRENDS

The ecosystem of climate tech providers has grown significantly over recent years. Tech Nation's 2022 Climate Tech report records 44,595 companies developing technology solutions to tackle the climate crisis, a four-fold increase since 2010, collectively raising $111bn in growth capital in 2021. CommerzVentures' Climate Fintech report found that climate fintech start-ups raised $2.9bn in 2022, 2.4x more than in 2021 than in all of 2021. Many spatial finance applications could be categorised in one or more (sub) categories of climate (fin)tech but the overall trend is clear: investment in new analytical solutions in growing rapidly.

In this report we first look at the state of spatial finance, zooming in on the three application areas that have seen the most traction . We then look at three trends in green finance that will continue to drive demand for new spatial finance solutions.

CLIMATE FINTECHS RAISED

$2.9bn

2.4x

MORE THAN IN 2021

Funding Volume in $m by Space

Category	$m
Carbon Accounting	$970
Carbon Offsetting	$505
Carbon Credits Trading	$400
Climate Risk Management	$343
Sustainable Banking	$230
ESG Reporting	$186
Supply Chain Analytics	$71
DeFi x Climate	$66
Impact investing	$55
Impact Financing	$40
Natural Capital Accounting	$34

Venture capital funding per category for climate fintech start-ups. Source: CommerzVentures

SPATIAL FINANCE APPLICATIONS

In our first Spatial Finance State and Trends report we described 11 spatial finance applications, their maturity and market potential, across two categories:

- Sector agnostic insights: Exposure of assets, companies and sectors to large, systemic physical issues such as climate change, pollution or environmental degradation, irrespective of the industry or asset type. E.g. heat stress, air pollution

- Sector specific insights: Indicators and proxies that are relevant to specific industries. E.g., footfall data for retail profitability, oil storage capacity

The growth in spatial finance applications is predominantly in sector agnostic solutions: applications where external environmental insights apply more or less equally to individual assets, irrespective of sector specific operational considerations, and tools that are focused on screening risks across entire, sectorally-diversified portfolios.

Government

Finance sector
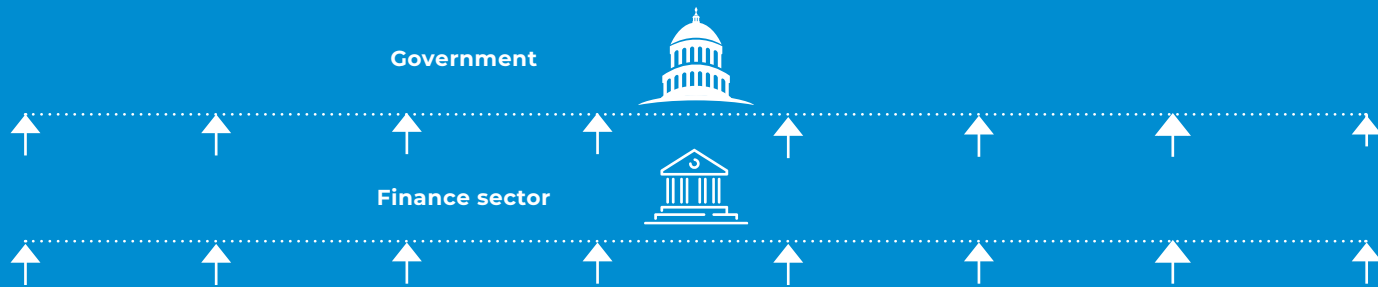
INDUSTRY AGNOSTIC INSIGHTS
E.g. water stress, heat stress, air pollution, wildfire risk

INDUSTRY SPECIFIC INSIGHTS
E.g. footfall data, commodity production indicators, crop yields

INDUSTRY SPECIFIC ASSET CHARACTERISTICS
E.g. commodity produced, technology, fuel inputs

| Extractive Industries | Agriculture, Forestry, Fishing | Heavy Industry | Manufacturing, Processing | Transport, Logistics | Utilities | Services, Retail, Real estate | Public sector |

There is significant untapped potential for sector specific geospatial solutions to be developed for the financial services sector. This is particularly relevant to sector specific (decarbonisation) targets being set by financial institutions, aiming to align with the decarbonisation pathways that are taking shape for individual real economy sectors — many of which have a long track record in using geospatial solutions to support their operational decision-making. Examples include flaring and environmental monitoring by oil and gas producers, monitoring of water/power transport infrastructure by utilities, or crop management and precision agriculture by agribusinesses. Similar insights can be relevant for financial institutions, especially if they are translated into risk or other metrics and when they are generated across all investable companies in a sector or portfolio.

In this report we zoom in on three spatial finance applications that have seen the most traction or growth since the publication of our 2021 report:

- **Physical climate risk analytics**

- **Environmental markets monitoring, reporting and verification (MRV) solutions**

- **Nature and biodiversity analytics**

THERE IS SIGNIFICANT UNTAPPED POTENTIAL FOR 'SECTOR SPECIFIC' GEOSPATIAL SOLUTIONS TO BE DEVELOPED FOR FINANCIAL INSTITUTIONS
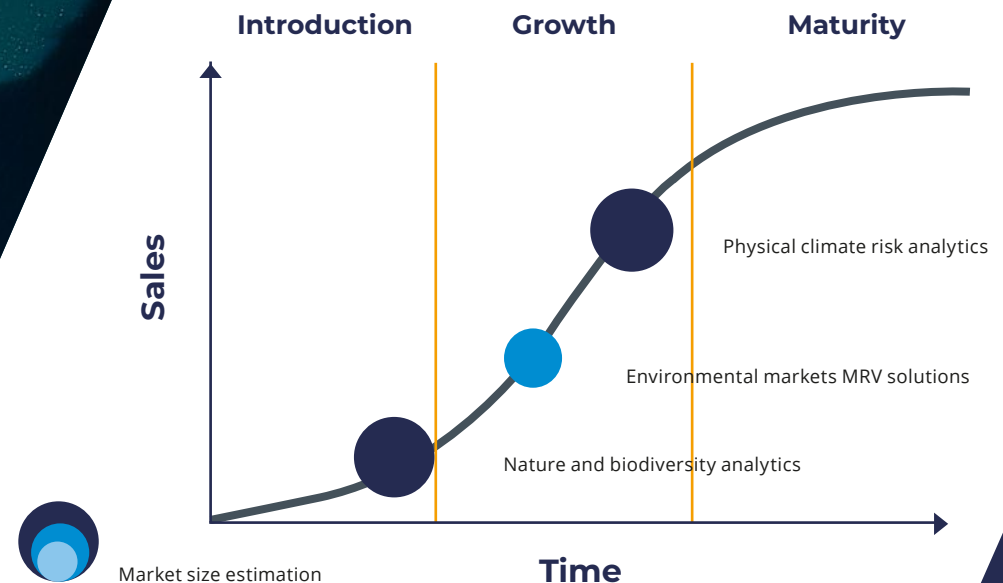
1. Physical climate risk analytics

Record breaking temperatures, droughts, floods, wildfires and other natural disasters are already causing significant financial and economic losses across both mature and emerging markets today. As these are set to increase in the future, they need to be priced into investment and financing decisions.

Mandatory climate risk disclosures and financial regulators' stress testing exercises (e.g. Bank of England, European Central Bank) that incorporate physical climate impacts are encouraging financial institutions to expand internal risk analytics capabilities. As these stress tests become more sophisticated in incorporating both chronic and acute climate hazards, so will financial institutions' understanding of these risks.

Spatial finance solutions for analysing physical climate risks are increasingly being adopted by financial institutions. We've seen a growing number of analytics businesses developing tools for both corporates and financial institutions to identify, assess and manage all possible physical climate risks. As these manifest themselves differently in different geographies, most of these solutions are inherently geospatial and rely on asset location information. Asset location is either uploaded by the user, or acquired from public and private asset databases. Most of these solutions are sector agnostic, but a subset of these tools focuses on real estate assets and investors.

While this application area has seen a lot of growth and investment in the last few years, there is significant potential for further growth or new solutions as asset information improves, forward-looking climate scenarios become more sophisticated, and financial institutions get

better at understanding physical climate risks and its financial implications.

Examples of commercial solution providers in this space:

- Cervest
- Climate X
- Cross Dependency Initiative (XDI)
- Fathom Global
- Jupiter
- RiskThinking.AI
- Sust Global

Examples of open solution providers in this space:

- Global Resilience Index Initiative
- OS Climate

Drought lowers the Rhine river, Germany. Source: Planet
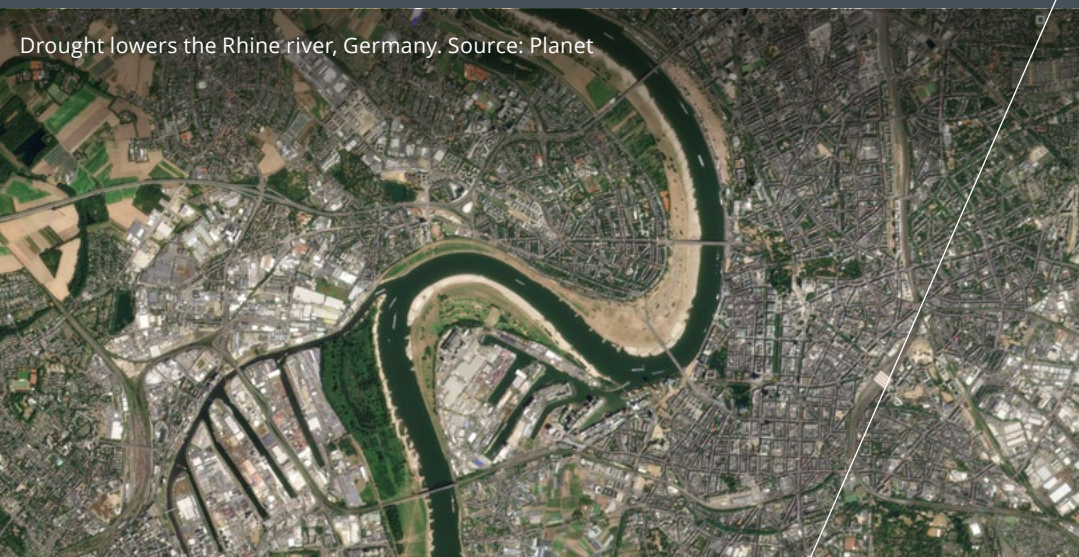
2. Environmental markets monitoring, reporting and verification solutions

Increasing numbers of net zero commitments from companies around the world are driving demand for carbon offsets, as companies seek to compensate for the (residual) greenhouse gas emissions from their operations or supply chains.

Many of these offsets are generated through so called nature-based solutions, where carbon is sequestered in trees or soils, or where offsets are avoided by protecting ecosystems from degradation or destruction. Beyond carbon, markets also exist for other ecosystem services such as clean water or biodiversity, where land owners, land managers or project developers are paid for measurable outcomes around ecosystem conservation or restoration. The integrity and quality of these offsets is crucial for the credibility of these markets and the companies that rely on them to deliver on their net zero commitments.

Digital technologies are being implemented to ensure and verify that environmental outcomes are actually achieved on the ground. In Singapore, for instance, a Singapore Exchange joint venture with, DBS, Standard Chartered and Temasek is building a global carbon exchange and marketplace for the voluntary carbon market, leveraging satellite monitoring, machine learning and blockchain to enhance the transparency, integrity and quality of carbon credits.

Overall, we've seen geospatial tools start to play an increasingly important role in monitoring, reporting and verifying outcomes from nature-based solutions used for environmental baselining for new projects to better understand additionality, monitoring of projects to

understand actual outcomes (e.g. carbon captured) and leakage (e.g. deforestation) to other geographical areas, or to assess physical risks that could impact the permanence of nature-based solutions (e.g. wildfires).

Examples of commercial solution providers in this space:
- GeoTree
- Kanop
- Natural Capital Exchange
- Pachama
- Pivotal Earth
- Single Earth
- Sylvera
- Treeconomy

Danube delta wetlands. Source: European Space Agency
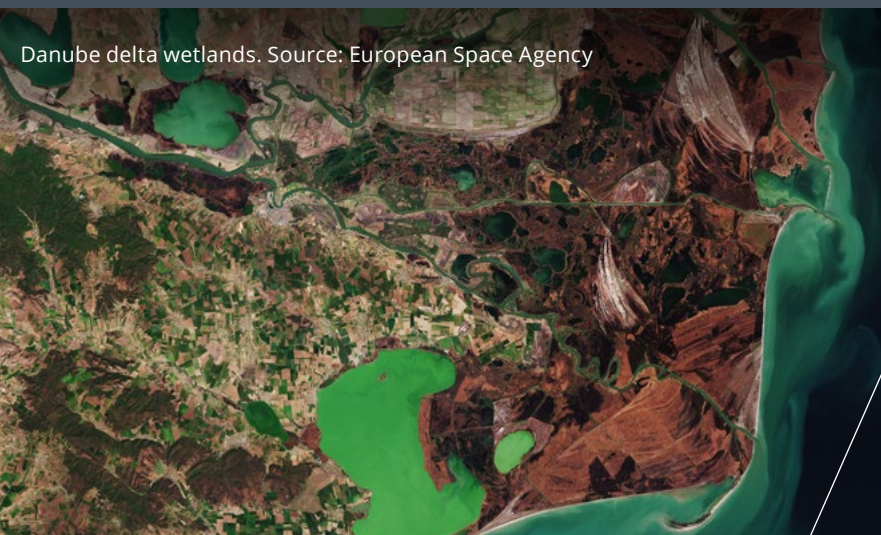
3. Nature and biodiversity analytics

The importance of nature for our global economic system, and the nature-related financial risks and opportunities associated with rapid nature and biodiversity decline, have been increasingly acknowledged globally by corporates, financial institutions, regulators and policymakers. This culminated in the Kunming-Montreal Global Biodiversity Framework at the United Nations Biodiversity Conference (COP15) in Montreal in December 2022, when almost 200 countries agreed to new goals and targets to address biodiversity loss and restore ecosystems.

Before governments formally declared these nature and biodiversity ambitions at COP15, central banks had already understood that nature-related risks could have significant macroeconomic and financial implications. Central banks in the Netherlands and France have started to quantify their respective jurisdictions' exposure to these risks.

At the same time, private sector coalitions, such as Business for Nature or the Finance for Biodiversity Pledge, are being established to better understand the topic and share best practice on measuring and managing risks. The Taskforce for Nature-related Financial Disclosures (TNFD) is one of the most comprehensive initiatives in this space and is currently developing a framework to identify, measure and mitigate nature-related financial risks through the lens of "double materiality" addressing both dependencies and impacts on nature.

The availability and quality of natural resources and biodiversity is inherently location specific. The analysis of nature-related dependencies and impacts, and the risks associated with them, will therefore require geospatial analysis. This is acknowledged in the TNFD's "Locate-Evaluate-Assess-Prepare" approach for nature-related risk and opportunity assessment.

While numerous geospatial nature-related tools and datasets exist in the scientific, non-profit and environmental services communities, few of them are currently tailored for use by financial institutions. As interest in the topic and demand for analytics increases, there is huge potential for new spatial finance applications and solutions to be developed in this area.

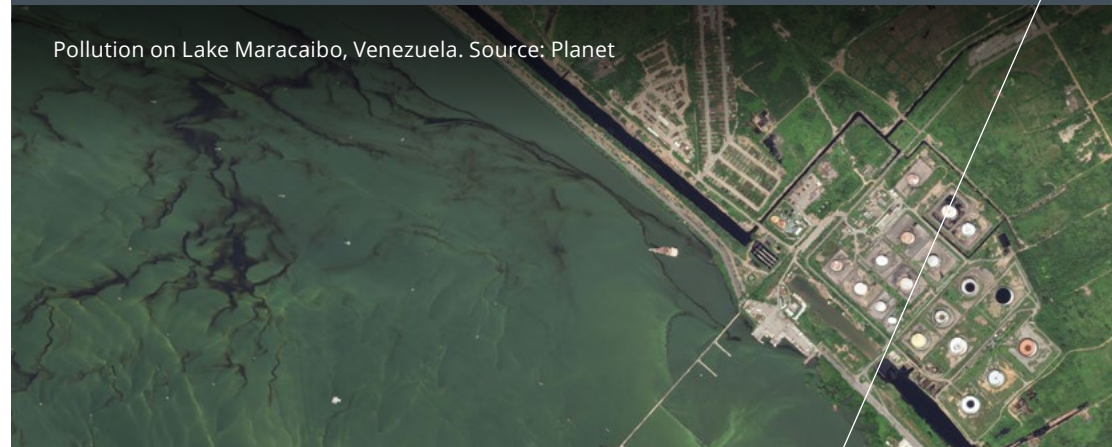**Examples of commercial solution providers in this space:**
- NatureAlpha
- Naturemetrics
- Quantifying Nature
- Satelligence

Examples of open or hybrid solution providers in this space:
- Global Forest Watch
- Integrated Biodiversity Assessment Tool
- Trase
- WWF Biodiversity/Water Risk Filter

Pollution on Lake Maracaibo, Venezuela. Source: Planet

TRENDS DRIVING DEMAND FOR SPATIAL FINANCE

Developments in green finance and the financial system's growing interest in, and commitments to, addressing various sustainability issues, are a significant driver of demand for spatial finance solutions. But after years of growing demand for green finance and the accompanying explosion of green financial products, the industry is facing credibility issues. There has been no shortage of pledges and commitments from financial institutions to tackle climate change, but greenhouse gas emissions continue to rise and climate-related economic losses continue to increase. As regulators are starting to crack down on greenwashing, we're also seeing financial institutions themselves start to back-track on their own commitments.

Nonetheless, demand for sustainable investing continues to grow and the need to allocate capital to genuinely green, sustainable, or resilient activities is as great as ever. Delivering on the Paris Agreement to keep global warming well below 2°C, investing in climate resilient infrastructure around the world, and reversing biodiversity loss will require trillions of dollars of investments. This will mean financial institutions need to integrate sustainability considerations into every investment or financing decision they make, and provide meaningful support to the real economy as firms transition to a low-carbon, climate resilient, and nature positive, economy. Spatial finance solutions can support financial institutions to regain credibility and to turn green finance theory into practice.

While we've seen growth across different types of spatial finance applications, we believe there is scope for many more types of applications" to "scope for many more applications, addressing new and evolving green finance use cases. In this report we look at three trends in green finance that could benefit from geospatial solutions:

- **Increasing demand for integrity in green finance products and claims**
- **Financial institutions embracing complexity of sustainability issues**
- **Need for more effective and impactful investor engagement**

DEMAND FOR SUSTAINABLE INVESTING CONTINUES TO GROW AND THE NEED TO ALLOCATE CAPITAL TO GENUINELY GREEN ACTIVITIES IS AS GREAT AS EVER

1. Increasing integrity: Due diligence, monitoring and reporting for green financial products

In 2022 various regulators started to address the issue of "greenwashing" — where companies or financial institutions claim more green credentials and impacts than they have actually generated. In Germany, Deutsche Bank and DWS were under investigation for greenwashing, while in the UK the Advertising Standards Authority has banned two adverts by HSBC because of misleading environmental claims. Also in the UK the Financial Conduct Authority is proposing new rules to tackle greenwashing. Earlier in the year the "EU taxonomy for sustainable activities" came into force, in effect differentiating sustainable economic activities from non-sustainable ones to protect investors from greenwashing.

At the same time, there is growing scepticism towards sustainability-linked financial products and their actual real-world outcomes. We're also seeing some large financial institutions reconsidering their climate commitments as these become more stringent. Greenwashing, the limited real-world impacts of green financial products, and backtracking on climate commitments by large investors, are eroding the trust of the general public and investors alike in the financial sector's ability to support a sustainability transition.

Despite eroding trust, demand for sustainable funds continues to grow and the need to allocate capital to genuinely green, sustainable, or resilient activities is as great as ever. This creates an opportunity for data and analytics that are reliable and verifiable to underpin green finance products.

Geospatial datasets have inherent qualities which enable this. Observed data (from remote sensing) is more neutral than reported data. It is also more readily available to external parties as the data is owned by external data providers or governments who make it available free of charge, allowing for scrutiny by multiple and independent stakeholders.

The data and analysis can be used for customer or product due diligence, screening for current risks, assessing historic liabilities, or monitoring progress or alignment of companies with sustainability targets. It can also be used to develop transparent green financial products to monitor or report on the real-world outcomes associated with those.

Deforestation in the Amazon rainforest. Source: European Space Agency

2. Embracing complexity: Moving away from single sustainability ratings to more granular, issue specific insights

Despite the rapid rise of "ESG investing" over the last few years, recent criticism and greenwashing issues are making ESG as concept or framework less useful for financial institutions. ESG ratings which aggregate environmental, social and governance topics into one or a few single metrics, have limited correlation between different rating providers, which makes it difficult to evaluate a company's ESG performance consistently.

At the same time, financial institutions are strengthening internal sustainability teams by actively recruiting staff with new and specialist data or sustainability skills. This means they become better equipped to look at individual ESG issues in more depth, or to tailor strategies to their client's ultimate objectives, be they ethically (impact) or financially (risk) driven.

Another evolution that shows the growing nuance in sustainability thinking by financial institutions, is the sector specific net zero targets that are being set — particularly by banks. Members of the Net-Zero Banking Alliance commit to setting (real economy) sector specific net zero targets and publishing progress against them. At the same time non-profit research initiatives such as the Rocky Mountain Institute's Centre for Climate Aligned Finance, and reporting initiatives such as the Transition Plan Taskforce or the TNFD, are preparing sector specific guidance on decarbonisation pathways and net zero transition planning.

As financial institutions start to appreciate and understand the complexities of various sustainability topics, and build the internal capabilities to do so, demand for more granular and specialist data and analytics will grow. We're starting to see incumbent (ESG) data providers prepare for this by partnering with or acquiring smaller, more specialised, sustainability analytics players.

Geospatial analytics will be essential for analysing real-world sustainability risks, opportunities and impacts at a more granular level to understand the local context and condition of a company's operations. Geospatial data can be translated into issue specific or sector specific insights, and used as building blocks for new financial and sustainability metrics at the physical asset level.

Illegal gold mining, Apamprama Forest Reserve, Ghana. Source: Planet
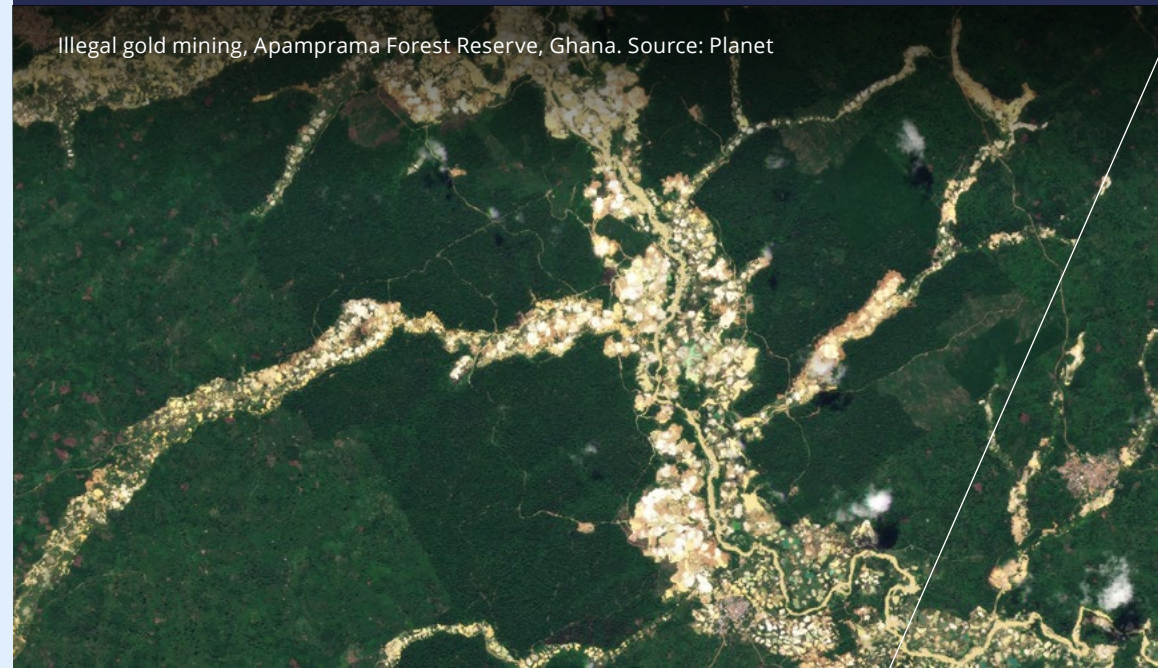
3. Empowering active ownership: Leveraging the potential of investor engagement to deliver outcomes, not just outputs

One way financial institutions can influence changes in the 'real economy' is through engagement and stewardship activities with clients and investees. This is often seen by investors as a more effective way of having a real-world impact, rather than divesting from polluting companies. Investor engagement coalitions such as Climate Action 100+, Nature Action 100 or FAIRR pool their resources to influence companies on specific topics. But their effectiveness in delivering change is increasingly being questioned. Either engaged companies are not pressured enough to safeguard financial returns, or the ambitions of the engagement campaigns are set too low.

Campaign objectives typically focus on commitments, disclosures or the endorsing of specific policies, but stop short of asking or monitoring real-world impacts and outcomes. If financial institutions are to justify engagement-based sustainable finance strategies, they need to start delivering outcomes rather than outputs.

Geospatial data and analytics can be powerful tools for financial institutions to achieve this across a range of sector specific or sector agnostic climate and environmental issues. As well as providing more granular, objective and accessible insights, remote sensing data is collected much more frequently than companies' reporting cycles, allowing investors to track progress of sustainability outcomes in near real time. Spatial finance analysis can be used to identify priority engagement targets, establish outcome baselines and monitor progress. It can also be used by financial institutions to

Tailings pond failure Jagersfontein, South Africa. Source: Planet

verify company disclosures or statements and to report back to their own stakeholders.

An example of an investor-led engagement campaign based on satellite data is Actiam's collaboration with Satelligence to combat deforestation in palm oil supply chains. The group of investors used satellite imagery analysis to capture deforestation incidents in companies' supply chains to inform their engagement conversations. Where palm oil supplier information was not available, they asked companies to disclose this information first, to allow them to monitor conditions on the ground. A similar approach was taken by the Investor Mining and Tailings Safety Initiative that demanded mining companies disclose tailings facility information (including location) to allow for independent monitoring of tailings management and safety, following the catastrophic tailings dam failure in Brumadinho, Brazil in 2019.

SPATIAL FINANCE INITIATIVE

ASSET DATA: THE FOUNDATION OF ACTIONABLE SPATIAL FINANCE APPLICATIONS

A crucial building block to make geospatial datasets relevant for financial institutions is asset data, linking physical assets and their operational characteristics to their exact location and ownership. This location-ownership connection is essential as it allows geospatial datasets and insights to be attributed to corporate entities and therefore to financial assets such as loans, bonds or publicly listed equities.

However, asset data is hard to find for financial institutions, particularly in a format that allows for climate and environmental analysis. Both the TNFD and WWF identify access to asset (location) data as a key data gap for green finance. While ShareAction's assessment of the 25 largest European banks' biodiversity and climate strategies ends with a recommendation to collect clients' location-level data on operations and supply chains to support more accurate risk assessments.

In an ideal world, asset data is made directly available by companies in a consistent format through public disclosures, APIs or upon request by financial institutions. But none of the (voluntary) sustainability disclosure frameworks currently include recommendations or guidance on asset data disclosures.

Commercial asset data providers on the market today typically cover only one or a few economic sectors. Many of these databases have been collected for sector specific market research or marketing purposes and are not necessarily suitable for climate and environmental risk analysis. This is starting to change with specialist companies such as GRESB's Asset Impact, aggregating and standardising different sectoral databases to enable climate and environmental analysis by financial institutions. As well as larger, risk analytics companies such as Moody's ESG compiling their own internal asset (location) database to underpin their own analytical solutions.

On the non-profit side we have asset data providers such as Global Energy Monitor that pioneered the creation of open asset data by starting to document coal-fired power plants in the United States, and that now covers numerous energy related sectors. As well ass the Spatial Finance Initiative's own GeoAsset project that develops open asset databases for heavy industry and other non-energy sectors.

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GeoAsset - Digital footprint of the global economy

The Spatial Finance Initiative's GeoAsset project creates and disseminates open, global asset databases for high impact industries. In a manner that is analogous to the Human Genome Project, GeoAsset aims to create a digital footprint of the global economy by collecting openly available information on physical assets (e.g. location, ownership, capacity) and aggregating these in standardised templates.

The GeoAsset project uses a combination of manual and machine learning techniques to analyse satellite, geo-spatial and web-based datasets to extract asset-level information in a way that is transparent, repeatable and allows for open publication of the derived insights. These databases, and any derived (geospatial) analyses, could lead to significant public-good benefits and increased transparency, not only for financial actors but also for businesses, civil society and policymakers.

The GeoAsset project currently covers the following industries:

- Cement
- Iron & Steel
- Aluminium
- Petrochemicals
- Pulp & Paper
- Waste Management
- Beef Production

GEOASSET CREATES OPEN, GLOBAL ASSET DATABASES FOR HIGH IMPACT INDUSTRIES

CASE STUDY: ASSESSING ENVIRONMENTAL IMPACTS IN BEEF SUPPLY CHAINS

A transition in our global food system is needed to ensure it can sustain a growing population while staying within planetary boundaries. Given the beef sector's significant reliance and impacts on nature and the climate, these environmental crises pose material financial risks to beef sector investors and businesses alike. While the availability and quality of disclosed information in the sector is limited, geospatial and asset-level data can be used to generate granular and actionable risk exposure insights. At the Spatial Finance Initiative, we have developed two methodologies to measure upstream environmental impacts for the beef sector, combining asset, geospatial and lifecycle assessment datasets.

Background

The way our agricultural and food system is organised has a substantial impact on our environment, particularly through land use, freshwater use, biochemical flows and greenhouse gas emissions. Within the food sector, the beef and dairy industry has an outsized role in these impacts, accounting for 17.4% of global greenhouse gas emissions and 38.5% of deforestation globally.

A large proportion of food producers globally does not disclose its environmental impacts. And while nearly half of the food producers targeted by the Carbon Disclosure Project (CDP) disclose some of their emissions for purchased good and services, this data is often incomplete, inaccurate and incomparable. Disclosure of deforestation risks by these same companies is even lower.

The bulk of the carbon footprint from food processing companies comes from their (upstream) supply chains, which is categorised as scope 3 emissions (e.g. purchased goods and services, use of sold products). Companies and investors alike often state that it is very costly to obtain reliable data on scope 3 impacts due to challenges in coordinating the collection and analysis of 1,000s of suppliers and middlemen across complex and geographically stretched value chains.

Ultimately, this lack of reported data impedes investors in understanding and mitigating the high environmental impacts and risks associated with their portfolios.

Spatial finance approach

We have developed two methodologies for estimating upstream scope 3 emissions for beef production which we applied to the five largest beef meatpackers globally: JBS, Marfrig, Tyson, Minerva and Cargill. Both methods require abattoir information, including exact location and production capacity, which was collected from corporate, government and news sources. Abattoir facilities were prioritized as they are the nodal points in the beef supply chain. Not only are they typically owned by large-scale, publicly listed meatpacking firms, but they are also located in proximity to farming areas.

Our first methodology combines lifecycle assessments and country level deforestation data. To assess lifecycle emissions of beef

production, we use country-level data on the type of production (i.e. whether animals are finished in feedlots or grassland), the average weight of animals at the time of slaughter, and emission factors from lifecycle analyses in these specific conditions. In addition, country-level statistics on deforestation from pasture conversion are assigned to specific abattoirs based on their share of beef production within the country. Those are amortised over 20 years as recommended by the GHG protocol, to capture soil carbon dynamics associated with specific land use activities. By combining these two inputs we estimate for each abattoir the emissions from animal rearing up to the abattoir gate, based on the facility's production capacity.

A second methodology is based on global carbon flux models. 'Carbon flux' is the difference between gains and losses per unit area of land with respect to the carbon reserves that can be found in a given place. In some models this information has been derived specifically for pastures and rangelands, which are used for livestock breeding and rearing. These models can be used as a proxy of the emissions occurring on pastures and rangelands, which are mostly associated with land use changes, methane emissions directly resulting from the enteric fermentation of animals, and nitrous oxide emissions from animal manure. By overlaying carbon-flux models and stocking rate data on the amount of cattle per hectare, we can estimate the annual average CO2 eq emissions per head of cattle occurring in the vicinity of an individual abattoir. Correcting for the average duration of the lifecycle in each country and considering each abattoir's capacity, we are able to allocate these emissions to individual facilities, based on their production capacity.

ABATTOIR FACILITIES WERE PRIORITIZED AS THEY ARE THE NODAL POINTS IN THE BEEF SUPPLY CHAIN

Agricultural fields near Hereford, Texas. Source: European Space Agency

Results

Both methodologies provide a scope 3 emissions estimate at the abattoir level, which can then be aggregated at the company level. Preliminary results show that these scope 3 emissions for the top 5 beef meatpackers are between 10-100 times higher than their reported scope 1 and 2 emissions combined. Both methodologies generate results in the same order of magnitude, which reinforces the robustness of using 'spatial finance' methods to assess environmental impacts at the abattoir level.

The methodologies developed rely on the use of country averages and proximity analysis to assess emissions at a facility-level.

Hence, they do not necessarily cover the exact impacts occurring within each of the farms supplying a plant. While the methodologies can obviously be improved by refining assumptions and reducing dependence of national averages, they offer an initial comparable data point on scope 3 emissions, where previously there was none. As such they can be a powerful tool for financial institutions to move away from their reliance on corporate disclosures, and understand with more granularity where the most material impacts of companies occur. This can inform emissions accounting, client screening, investee engagement or the development of new transition finance products.

The abattoir asset data that was collected is openly available as part of our GeoAsset project here. The results and full methodology of this study will be submitted to an academic journal and undergo a peer review process before publication. Contributors include Juan Sabuco, Ben Caldecott, Christophe Christiaen, Laura Garcia Velez, Felicia Liu, Nataliya Tkachenko

CONCLUSION

As many climate and environmental issues are inherently location specific, they are best understood in their local context. Spatial finance allows financial institutions to analyse risks, impacts and opportunities from the bottom-up, leveraging geospatial data and analysis. While many geospatial datasets and technologies are readily available today, technologies for capturing and processing location specific data continue to improve. At the same time green finance keeps growing and evolving. We are seeing financial institutions pledging to tackle specific environmental issues and financial data providers building strategic partnerships with geospatial data providers. The time is ripe for spatial finance to become mainstream.

There is a lot of untapped potential at both the demand and supply side of spatial finance. Today, financial institutions can already access commercial and non-commercial spatial finance solutions, particularly for physical risk analysis, monitoring outcomes in environmental markets or understanding nature and biodiversity dependencies and impacts. But they need to build the internal capacity to process these analytics and interpret the outputs. Geospatial analytics providers have proven solutions that have been in use across different sectors for many years. They now need to translate these insights into tools and metrics relevant for financial institutions and to scale up their levels of analysis, looking at large numbers of assets across different geographies and balance scale versus detail, depending on the use case. Finally, spatial finance solutions are typically only relevant when geospatial insights are combined with financial and other non-geospatial inputs. Partnerships across the financial data value chain may be the most effective route to market.

Access to asset (location) data remains a big challenge for financial institutions and data providers. It's an essential building block that allows the wealth of readily available geospatial datasets to become relevant for financial institutions. Governments, financial institutions, data providers and research institutions can all play a role in increasing access to this data through including asset data disclosure requirements in reporting frameworks, publishing and standardising asset data that sit in public institutions or by developing new methodologies for creating asset databases. This would allow us to mainstream spatial finance and realise its full potential, delivering the transparency and accountability that green finance needs.
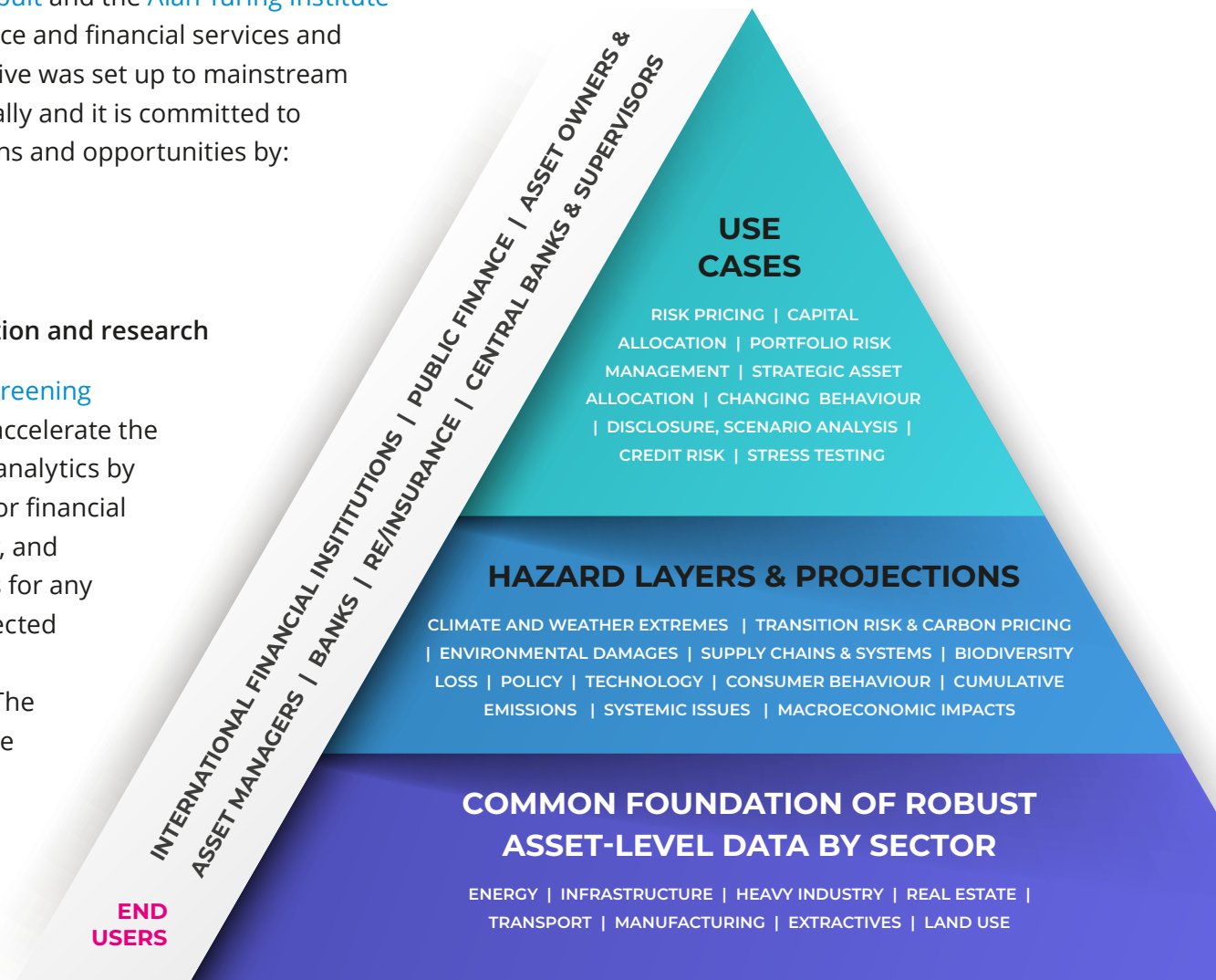
FINANCIAL INSTITUTIONS PLEDGING TO TACKLE SPECIFIC ENVIRONMENTAL ISSUES AND FINANCIAL DATA PROVIDERS BUILDING STRATEGIC PARTNERSHIPS WITH GEOSPATIAL DATA PROVIDERS. THE TIME IS RIPE FOR SPATIAL FINANCE TO BECOME MAINSTREAM

SPATIAL FINANCE INITIATIVE

ABOUT THE SPATIAL FINANCE INITIATIVE

The Spatial Finance Initiative has been established by the Oxford Sustainable Finance Group at the University of Oxford, the Satellite Applications Catapult and the Alan Turing Institute to bring together research capabilities in space, data science and financial services and make them greater than the sum of their parts. The initiative was set up to mainstream geospatial capabilities into financial decision-making globally and it is committed to promote and grow the wealth of spatial finance applications and opportunities by:

- Creating open, global asset databases

- Awareness raising and capacity building

- Promoting applied multi-disciplinary collaboration and research

The Spatial Finance Initiative is part of the UK Centre for Greening Finance and Investment, a national centre established to accelerate the adoption and use of climate and environmental data and analytics by financial institutions internationally. Its ultimate vision is for financial institutions to be able to access and use consistent, timely, and appropriate climate and environmental data and analytics for any point on planet earth historically, in the present, and projected into the future, for every major sector and the complete spectrum of material climate and environmental factors. The centre acts as a platform to connect environmental science and innovation with financial institutions, providing a route by which needs are understood and the latest climate and environmental science is translated for financial decision-making.

INTERNATIONAL FINANCIAL INSTITUTIONS | PUBLIC FINANCE | ASSET OWNERS & ASSET MANAGERS | BANKS | RE/INSURANCE | CENTRAL BANKS & SUPERVISORS

END USERS

USE CASES

RISK PRICING | CAPITAL ALLOCATION | PORTFOLIO RISK MANAGEMENT | STRATEGIC ASSET ALLOCATION | CHANGING BEHAVIOUR | DISCLOSURE, SCENARIO ANALYSIS | CREDIT RISK | STRESS TESTING

HAZARD LAYERS & PROJECTIONS

CLIMATE AND WEATHER EXTREMES | TRANSITION RISK & CARBON PRICING | ENVIRONMENTAL DAMAGES | SUPPLY CHAINS & SYSTEMS | BIODIVERSITY LOSS | POLICY | TECHNOLOGY | CONSUMER BEHAVIOUR | CUMULATIVE EMISSIONS | SYSTEMIC ISSUES | MACROECONOMIC IMPACTS

COMMON FOUNDATION OF ROBUST ASSET-LEVEL DATA BY SECTOR

ENERGY | INFRASTRUCTURE | HEAVY INDUSTRY | REAL ESTATE | TRANSPORT | MANUFACTURING | EXTRACTIVES | LAND USE

SPATIAL FINANCE INITIATIVE

CONTACT US

For more information and to engage with the Initiative, contact us at the address below.

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