SPATIAL FINANCE INITIATIVE

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STATE AND TRENDS OF SPATIAL FINANCE 2021

Next Generation Climate and Environmental Analytics for Resilient Finance

ABOUT THIS REPORT

This report is the Spatial Finance Initiative (SFI)'s first annual overview of spatial finance solutions and trends. As the first in the series, it delves deeper into the underlying technology advancements and market developments that make spatial finance an increasingly important proposition for financial institutions. It presents both emerging and mature applications that are already available on the market and highlights future trends.

The information presented here is drawn from publicly available sources and builds upon the deep experience of the authors in building geospatial solutions internationally. The report by no means claims to cover all the available spatial finance offerings but aims to show the breadth of solutions and opportunities available for applications in finance.

It will be of relevance to various audiences (C-level executives, managers, analysts, etc.) with different backgrounds (portfolio management, risk management, sustainability, etc.) within different financial institutions (asset owners, asset managers, hedge funds, banks, insurers, rating agencies, regulators, etc.). The insights will be equally relevant for financial sector professionals (accountants, consultants, actuaries) and stakeholders across government, civil society, or corporations.

The report has been written as part of the Spatial Finance Initiative and has been prepared by Christophe Christiaen (Satellite Applications Catapult) with contributions from Andrew Coote (ConsultingWhere) and Simon Wills (ConsultingWhere). The authors would like to acknowledge and thank the valuable comments and feedback provided by Sam Adlen, Peter Beaumont, Ben Caldecott, and Nicola Ranger.

IT DELVES DEEPER INTO THE UNDERLYING TECHNOLOGY ADVANCEMENTS AND MARKET DEVELOPMENTS THAT MAKE SPATIAL FINANCE AN INCREASINGLY IMPORTANT PROPOSITION FOR FINANCIAL INSTITUTIONS

CONTENTS

FOREWORD

The industry of finance and asset management is operating in an increasingly complex world. Financial institutions must continue to respond to evolving financial, economic, political, and regulatory contexts. To this set of challenges must now be added an understanding of the financial implications of climate change, biodiversity loss, and other environmental and social challenges which are becoming of increasing importance. These aspects can no longer be considered separate from an asset manager's fiduciary duty, as the impact and exposure of investments to these rapidly evolving trends will prove increasingly critical to risk and return.

As the challenges that we face evolve, so too must the capabilities through which we address them. To understand our exposure to the physical risks of climate change, the role of nature loss in our portfolios, and the way these reverberate through markets and supply chains, we can no longer rely only on traditional data. A company's ESG rating may tell us about the practices and policies it has in place, but it tells us little as to whether it will be in the path of the next hurricane, whether water excess withdrawals in its area will lead to water scarcity, or whether companies in its supply chain may find themselves wiped out over liability claims linked to deforestation or other environmental impacts.

To answer these questions, we need to leverage the powerful new capabilities of geospatial data and asset level information. Rapid reductions in the cost of earth observation, satellites and remote sensing have provided us with a wealth of new data. Climatologists and earth scientists already keenly exploit this data to inform a better understanding of our environmental models.
So too, however, must the financial world embrace this data if it is to remain well-prepared for the changes that are already occurring all around us.

This report provides an insight into the emerging world of spatial finance that is both timely and comprehensive. At Lombard Odier, we believe the digital revolution driven by new technologies – such as geospatial assessment capabilities – will prove to be one of the most powerful weapons in our arsenal as we tackle the challenges of a lifetime. In the case study on page 13, we provide some examples of how we, at Lombard Odier, are drawing on these new insights to inform our investment convictions.

As this report demonstrates, the field of spatial analysis is one that is rapidly evolving, with new applications continuing to emerge. As the field matures, these use cases will only continue to grow. The world of finance is an obvious match for this new area of expertise.

Christopher Kaminker

Christopher Kaminker
Head of Sustainable Investment Research, Strategy & Stewardship Lombard Odier

EXECUTIVE SUMMARY

Everything happens somewhere. The climate and nature crises, two of the most existential threats of our time, are inherently spatial. Greenhouse gas emissions are emitted or sequestered at different rates, from different processes, at different locations. Physical impacts of climate change are affecting us globally but manifest differently across location and time. Nature degradation and biodiversity loss are typically the result of local actions and affect ecosystems and populations mainly locally and regionally.

Spatial Finance, the integration of geospatial data and analysis in financial theory and practice, allows financial institutions to understand and manage risks, opportunities and impacts related to climate and the environment in a granular and actionable way. Advancements in geospatial technologies and data science are making it possible to collect asset-level information in a consistent, timely and scalable manner, increasing transparency for investors, policymakers, and civil society alike by aggregating insights at a company, sector or portfolio level from the physical asset level upwards.

This first State and Trends of Spatial Finance report showcases how spatial finance solutions are already being applied today and provides food for thought on how these technologies can be leveraged for the financial system of tomorrow. While solutions in insurance and commodity trading are mature, many novel applications are becoming available. offering climate and environmental analytics to support investment decisions in energy, built environment, agriculture markets and more.

THIS FIRST STATE AND TRENDS OF SPATIAL FINANCE REPORT SHOWCASES HOW SPATIAL FINANCE SOLUTIONS ARE ALREADY BEING APPLIED TODAY

However, the opportunity for further innovation is huge. As geospatial technologies and data science continue to improve, and as adoption across the financial system increases, new applications will emerge, from spatially enabled smart contracts to near real-time environmental, social and governance dashboards or predictive analytics. One prerequisite for this growth is accurate and up-to-date information about the exact location and ownership of assets in every major sector of the economy.

In a manner that is analogous to the Human Genome Project, it is now possible to produce universally trusted, transparent and verifiable asset-level datasets. Using geospatial technologies and data science techniques, we can sequence or decode the real economy and create a digital footprint for all assets across all industries on earth. If this data is then made publicly available, it would unleash a vast array of opportunities and applications and greatly enhance the ability of financial institutions and other actors to align their portfolios and strategies with climate and other environmental objectives.

5 KEY TAKEAWAYS

- **Spatial Finance enables bottom-up investment analysis**

  Geospatial and asset-level insights allow for a more fundamental assessment of risks, opportunities and impacts from the physical asset-level upwards which can be aggregated at the company, sectoral, portfolio or national level.

- **Geospatial and data science technologies create scalable and global datasets**

  Geospatial technologies are suitable for comprehensive financial analysis as geospatial data has become ever more ubiquitous, accessible and of improving quality from the hyperlocal to the global scale. In parallel, advances in data processing and AI techniques make these vast datasets ever more digestible and interpretable.

MANY SPATIAL FINANCE APPLICATIONS TODAY REMAIN LARGELY UNDEREXPLOITED, THROUGH LACK OF AWARENESS, ANALYTICAL SKILLS AND ASSET-LEVEL DATA TYING PHYSICAL ASSETS TO OWNERSHIP STRUCTURE

- **Next generation climate and environmental analytics for finance will be geospatial**

  Numerous spatial finance applications are already available today ranging from natural catastrophe modelling and commodity trading intelligence to physical climate financial risk analysis and biodiversity risk and impact assessment.

- **Digital footprint of the global economy will accelerate spatial finance innovation**

  In a manner that is analogous to the Human Genome Project, it is now possible to sequence or decode the real economy from space using EO, geospatial and AI techniques, to create universally trusted, transparent and verifiable asset-level datasets covering every major sector of the global economy.

- **Untapped potential creates commercial opportunities for early adopters and suppliers**

  Many spatial finance applications today remain largely underexploited, through lack of awareness, analytical skills and asset-level data tying physical assets to ownership structure. This creates commercial opportunities for pioneering data science companies and financial institutions to disrupt investment thinking and workflows.

SPATIAL FINANCE

What is Spatial Finance?

"Spatial finance" is the integration of geospatial data and analysis into financial theory and practice[1]. Combining earth observation and remote sensing with artificial intelligence can transform the availability of information in our financial system, and change how risks, opportunities and impacts are measured and managed by financial institutions and civil society[2]. By incorporating geospatial data into financial decision making, spatial finance provides an opportunity to enhance transparency within the financial system for both practitioners and data providers.

What is Geospatial Data?

Geospatial data is any type of information that is referenced to its geographical position on or above the surface of the earth, usually by expressing it in terms of latitude, longitude, height and critically, time. It helps to visualise what happens where, mostly simply in the form of maps. However, its use is far more valuable as a means of integrating otherwise unrelated data and finding patterns that cannot otherwise be easily identified.

Human geography such as mobility patterns is being used to reveal people movement and infer COVID transmission causes and street addresses to accurately locate business activity. Further, vast volumes of geo-referenced meteorological, geological, oceanographic, and hydrological data are driving environmental analysis and climate change prediction. In summary, once geospatial data is used to literally add another dimension to decision making, trends, relationships, patterns, changes over time and other important connections become evident.

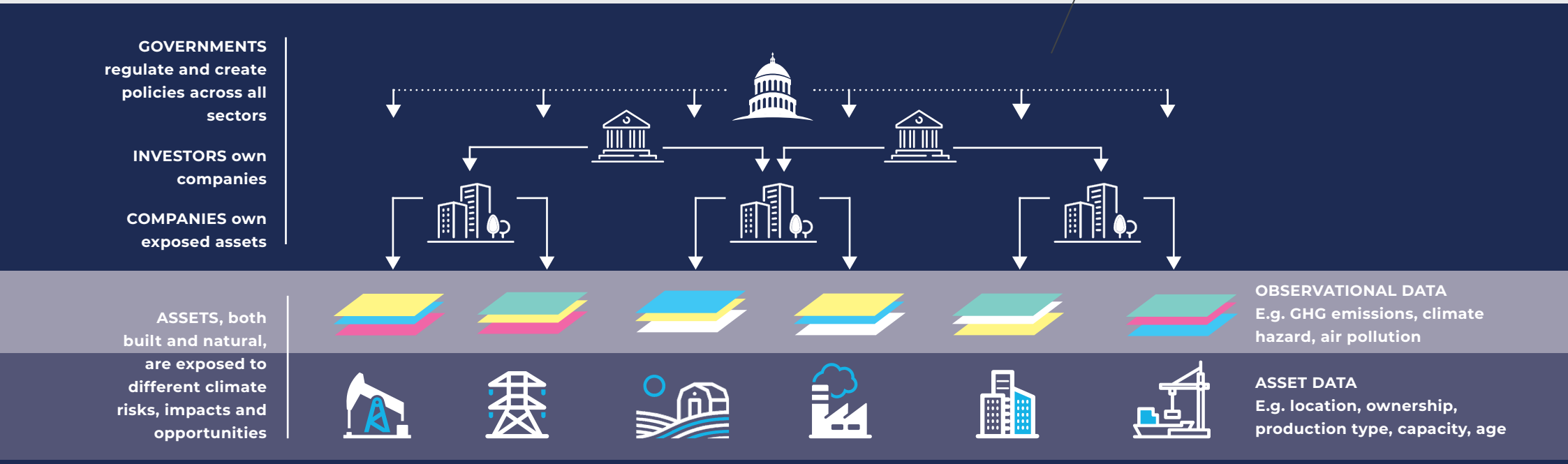
In the context of spatial finance, some of the most valuable types of geospatial data include pixel-based earth observation imagery from satellites and drones much of which is multispectral — enabling patterns such as vegetation growth, heat loss and even human migration to be analysed.

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

What is Asset-level Data?

Asset-level data is information about physical and non-physical assets (e.g., geolocation, asset type, capacity, productivity, age) tied to company ownership information[3]. This information is crucial to link geospatial and observed datasets with actors on the ground and their owners, investors, or stakeholders. Asset-level data can be aggregated at the company, portfolio, regional, or global level, addressing needs from asset managers through to policy makers and NGOs. Asset-level data enables objective, "bottom-up" approaches to measuring environmental risks and impacts, regardless of whether companies do or do not disclose relevant information.

ASSET-LEVEL DATA CAN BE AGGREGATED AT THE COMPANY, PORTFOLIO, REGIONAL OR GLOBAL LEVEL



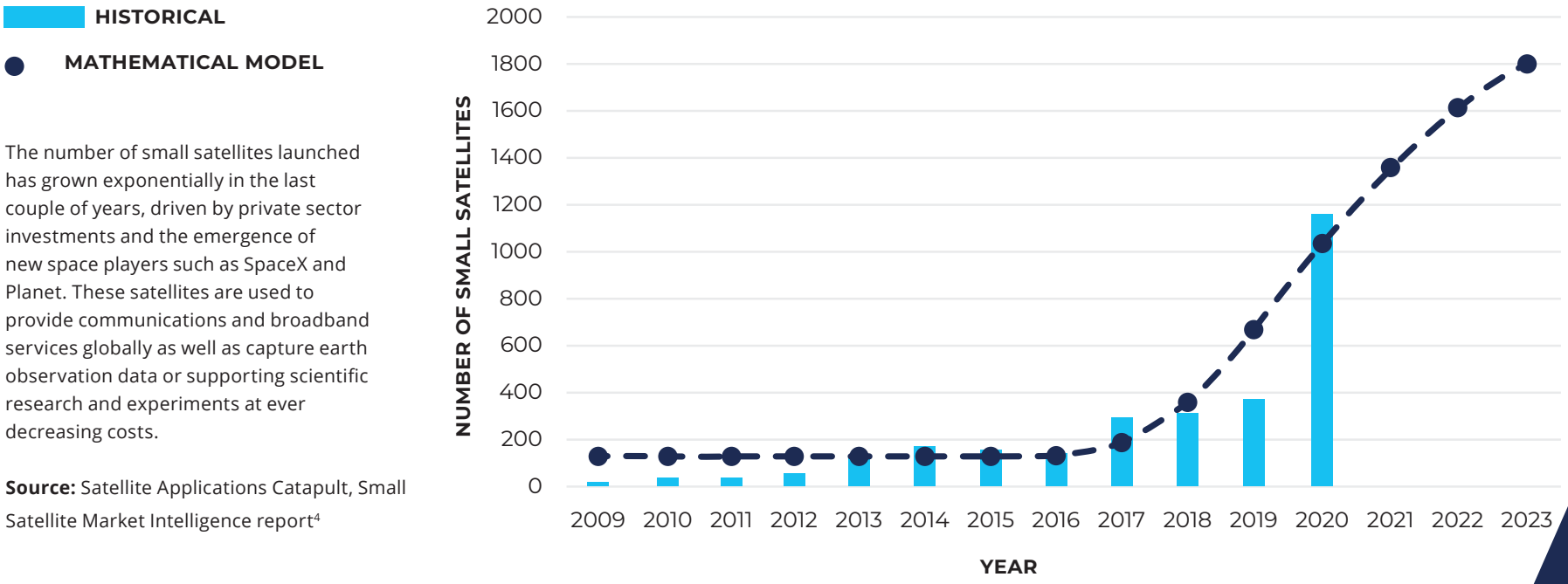
TECHNOLOGY ADVANCEMENTS

While geospatial data and technologies have been around for decades it is really in the last couple of years that we have seen rapid technology advances in geospatial data collection and processing, as well as alongside innovative business models from start-ups entering the market. This is creating insights at the scale and speed required for financial decision making.

Geospatial Data Collection

Geospatial technologies have seen significant decreases in cost and size which have resulted in an abundance of earth observing (EO) technologies such as unmanned aerial vehicles, high-altitude platforms, and small satellites. The increasing capabilities of unmanned aerial vehicles to operate "over the horizon" and support greater payloads will compete with sub-metre resolution, daily revisit EO imagery delivered from constellations of much smaller and cheaper satellites. Advances here will continue to be a game changer, resulting in an over-abundance of geospatial data with global coverage.

Number of Small Satellites Launched

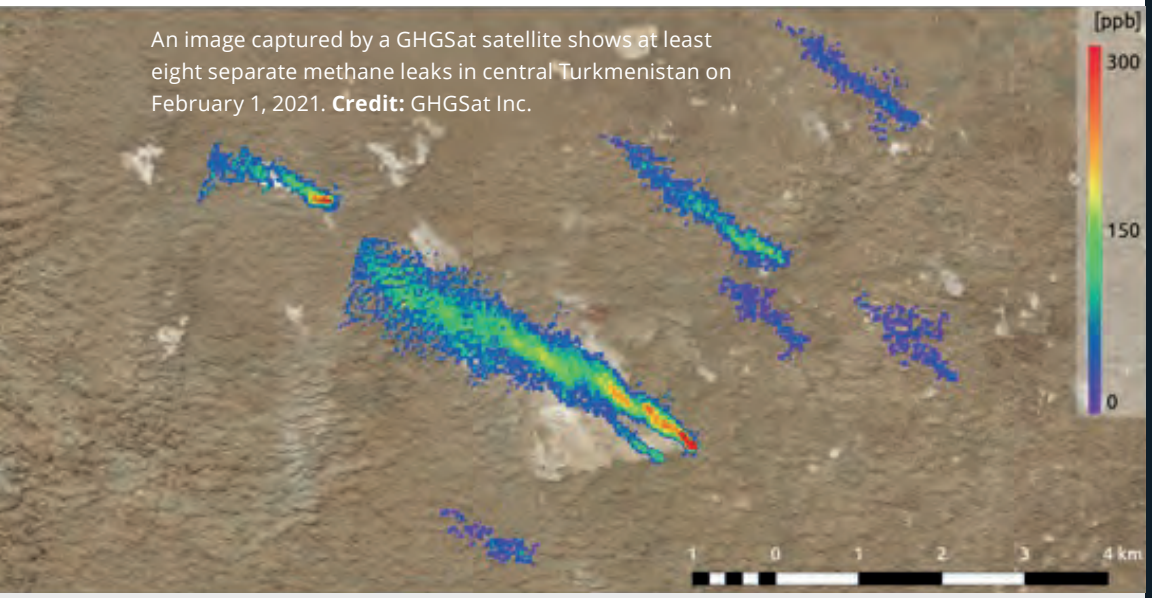


The number of small satellites launched has grown exponentially in the last couple of years, driven by private sector investments and the emergence of new space players such as SpaceX and Planet. These satellites are used to provide communications and broadband services globally as well as capture earth observation data or supporting scientific research and experiments at ever decreasing costs.

Source: Satellite Applications Catapult, Small Satellite Market Intelligence report[4]

To this can be added the impact of the Internet of Things (IoT), particularly public infrastructure and connected vehicles. We are now able to deploy sensors more easily, and in more locations, like railway stations, to monitor footfall and movement, or across whole cities to provide real-time monitoring of pollution levels.

The capabilities of smartphones to capture geolocated data continue to be enhanced with the latest generation, such as the iPhone 12, featuring multiple LiDAR sensors enabling creation of 3D images on a handheld device. Additionally, location Bluetooth Low Energy brings accurate positioning to indoor locations. These and other sensor enhancements usher in many applications of people as sensors with inherent ethical challenges, such as location privacy. These are being addressed by the establishment of international best practice protocols and "trust" management schemes.



An image captured by a GHGSat satellite shows at least eight separate methane leaks in central Turkmenistan on February 1, 2021. **Credit:** GHGSat Inc.

Reductions in satellite hardware and deployment costs have meant a surge in start-ups developing novel satellite constellations delivering high frequency, high resolution datasets:

- **GHGSat** satellites capture point source greenhouse gas emissions for any site in the world
- **ICEYE** cloud penetrating radar satellites capture data every couple of hours, night and day
- **Planet** captures optical imagery of the entire earth every day
- **Spire** datasets improve weather forecast accuracy and track maritime and aviation assets globally

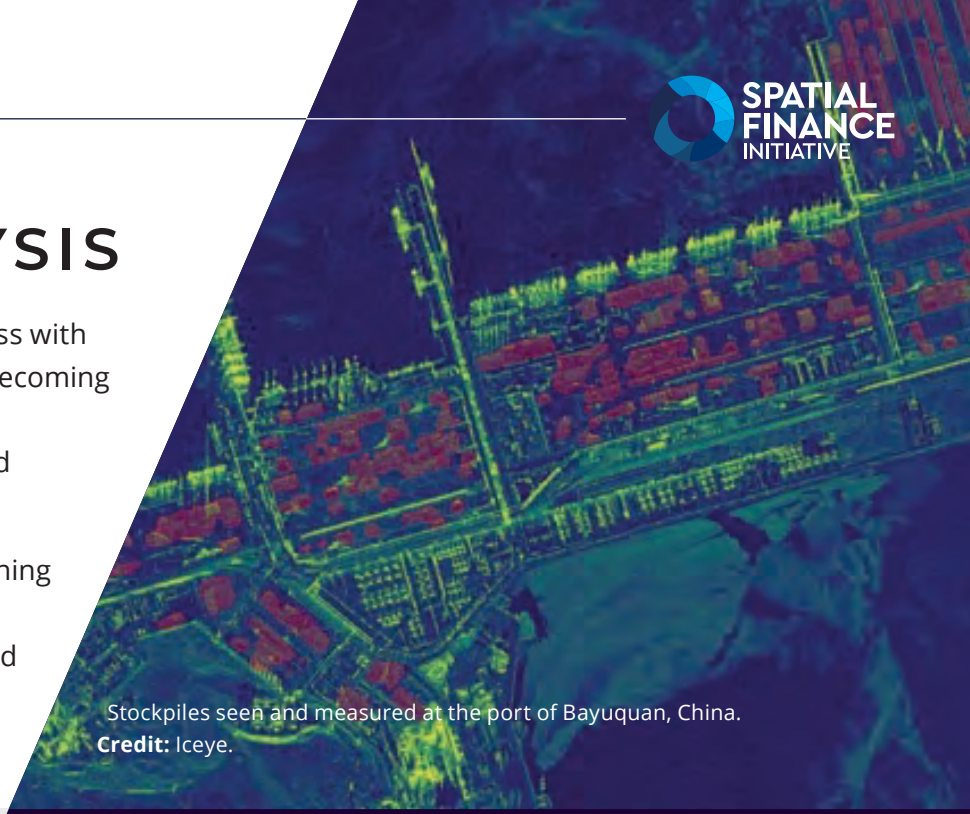
In parallel to commercial innovation, public institutions are investing in new earth observation capabilities and are making their datasets available free of charge.

- **Copernicus**, the EU's earth observation programme operated by the European Space Agency, provides a global high quality, continuous monitoring capacity, free of charge since 2014.
- NASA/USGS **Landsat** earth observation programme provides free of charge access to its archive of imagery, allowing unprecedented insight into global changes of our planet since 1972.

DATA PROCESSING AND ANALYSIS

These vast earth observation datasets have become much easier to access and process with the development of powerful cloud computing networks. Large tech businesses are becoming increasingly active in this space. Google Earth Engine, Earth on Amazon Web Services and Microsoft's planetary computer all provide access to huge volumes of satellite and geospatial datasets combined with powerful analytical capabilities.

Developments in big data analytics such as artificial intelligence (AI) and machine learning allow for automated analysis of large complex datasets. AI can be used to solve actual problems at scale by applying techniques such as machine learning, deep learning, and pattern recognition, to large volumes of geospatial data linked to other unstructured or financial datasets. The techniques available include:



Stockpiles seen and measured at the port of Bayuquan, China.
Credit: Iceye.

- Feature extraction from imagery to identify objects of interest from nuclear installations to distinguishing types of plastic waste.
- Pattern recognition based on clustering of data and its proximity or comparison of spatial data across time.
- Network analysis to track geographical footprints of transactions or individuals.
- Generative models creating new data by interpolation from multiple sources.
- Agent-based modelling that creates synthetic populations to predict future behaviours, as in recent COVID-19 pandemic simulations.

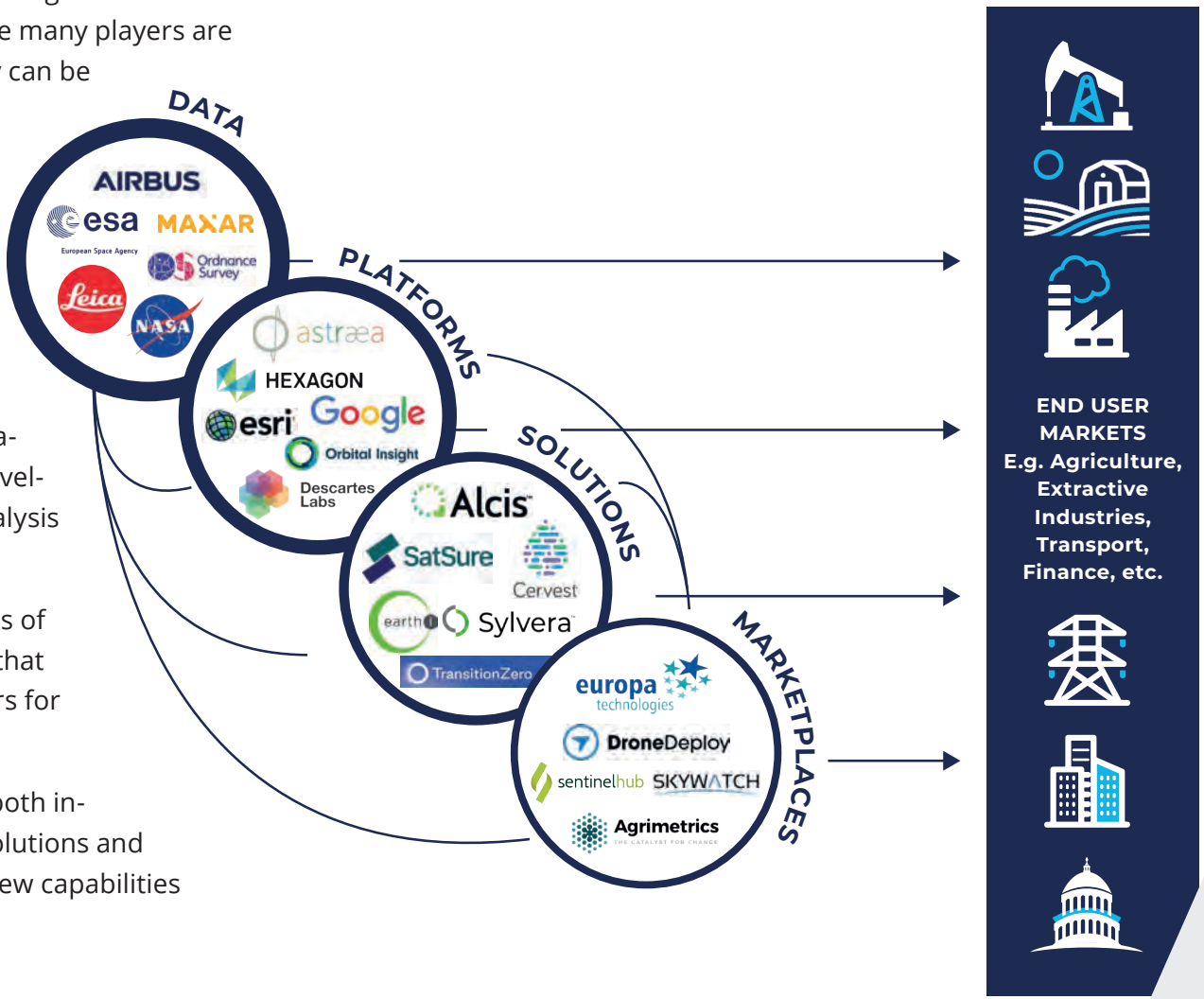
Much of this is enabled by the emergence of mainstream cloud services such as Platform (PaaS), Infrastructure (IaaS) or Software as a service (SaaS), which are suited to the manipulation and analysis of large datasets.

The ability to visualise data spatially over wide areas based on its location in space and time is enabling quicker and more informed decision making. State of the art visualisations borrow heavily from advances in computer vision and acquisition technology such as LiDAR and digital photogrammetry to produce digital twins of the real world. Patterns that are difficult to extract from database tables can be uniquely found and presented to users.

GEOSPATIAL VALUE CHAIN

These technological advancements are driving the creation of new company and business models into the market, allowing innovative ways for users to interact with the technology. While many players are active across multiple levels of the value chain, they can be broken down into four categories[5].

- **Data:** Data providers offering raw, semi-processed and processed geospatial data through simple APIs under a "Data as a Service" model typically based on hardware and sensor expertise.
- **Platforms:** Industry agnostic "Platform as a Service" solutions typically combine multiple datasets and offer a flexible environment with pre-developed functionalities for users to do their own analysis or build their own solutions.
- **Solutions and Services:** Smart aggregators of relevant geospatial and non-geospatial datasets that directly provide value added services and answers for industry specific challenges.
- **Marketplaces:** Marketplaces bring together both industry specific and industry agnostic datasets, solutions and expertise in a way that allows users to discover new capabilities more easily.



MARKET DEVELOPMENTS

Financial Sector Uptake

Besides more established applications in insurance and commodity trading, spatial finance approaches are increasingly being applied by financial institutions to address environmental, sustainability challenges across different asset classes. Climate change and exposure to physical and transition climate risk are increasingly being predicted and assessed using spatial and asset-level based approaches[6]. Lombard Odier, for instance, has been using satellite and geospatial data to forecast the location and severity of Australian fires[7]. Ninety One has used these approaches to anticipate the impacts of climate change on national economies and credit risk of sovereign debt[8].

As the understanding of our economies' and livelihoods' dependency on nature increases, so it does of the role that finance can play in restoring nature and biodiversity. Spatial finance is increasingly leveraged and promoted to monitor impacts of businesses on natural assets or compliance with environmental regulation[9]. Swiss Re, for instance, is applying these techniques to assess the risks and impacts of financing and re/insurance decisions, e.g., long-term impacts of economic activity and short-term disaster risk management such as oil spills[10]. The World Bank and WWF have developed a spatial finance analysis hierarchy considering different forms of technology, approaches and data within a single framework to support financial markets to realign towards sustainable development[11].

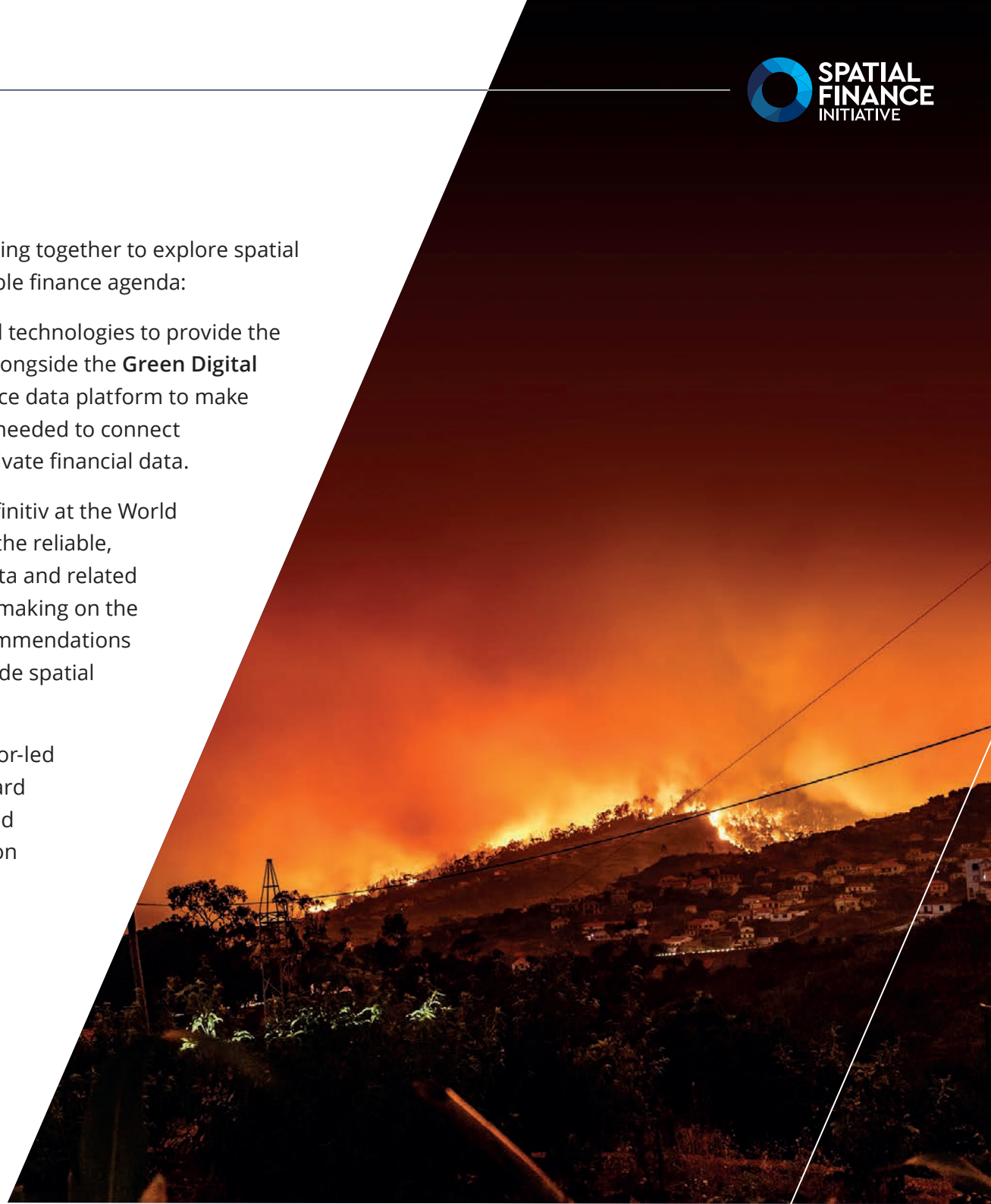
Building on this demand and technology advancements, financial data providers are starting to integrate spatial finance in their offerings

CLIMATE CHANGE AND EXPOSURE TO PHYSICAL AND TRANSITION CLIMATE RISK ARE INCREASINGLY BEING PREDICTED AND ASSESSED

and analysis. Bloomberg is increasingly making geospatial datasets available through its terminal to help its customers understand real-time weather events, longer-term climate risks and their impacts on global supply chains[12]. S&P Global Ratings is starting to integrate spatial finance techniques in its credit risk assessment, assessing links between the location of US public water utilities and their financial performance[13]. Truvalue Labs has used NASA data on greenhouse gas emissions to analyse methane super emitters in California, linking it to their shareholders and their sustainability commitments[14].

Global coalitions of investors and/or data providers are coming together to explore spatial finance approaches or applications to advance the sustainable finance agenda:

- The **Finance4Biodiversity** Initiative is looking at geospatial technologies to provide the finance sector with usable data for nature-related risks. Alongside the **Green Digital Finance Alliance**, the Initiative is developing an open-source data platform to make geolocated company-level activity data available which is needed to connect "upstream" public biodiversity data with "downstream" private financial data.
- The **Future of Sustainable Data Alliance**, convened by Refinitiv at the World Economic Forum in 2020, looks to identify and accelerate the reliable, actionable environmental, social and governance (ESG) data and related technology that is needed for improved investor decision making on the global journey to sustainable development. Its initial recommendations call for a move away from a singular dataset focus to include spatial and asset-level datasets for ESG analysis.
- The **Investor Mining & Tailings Safety Initiative**, an investor-led coalition convened by the Church of England Pensions Board and Swedish Council of Ethics of the AP Funds, has engaged with the mining sector to disclose safety critical information about their mining-waste storage facilities. This asset-level data is aggregated in a **Global Tailings Portal** to give communities, investors, regulators and the media unprecedented access to information about mine waste, in its geographical and socio-economic context.



LOMBARD ODIER CASE STUDY:
SPATIAL FINANCE INVESTMENT ANALYSIS

As an asset manager, managing both institutional investments and private wealth, Lombard Odier has a fiduciary duty to its clients to understand the exposure of the assets under its management to evolving risks and prospects for return.

Lombard Odier believes that the world is transitioning from one that is Wasteful, Idle, Lopsided and Dirty (WILD) to one that is Circular, Lean, Inclusive and Clean (CLIC™). This conviction reflects their view that the present economic model, built around excess reliance on fossil fuels and environmental impact, has grown increasingly unsustainable. To understand how individual companies and investments are positioned within this accelerating transition, spatial finance offers a powerful new tool that Lombard Odier has been one of the first adopters of, having embedded geospatial capabilities within its expanding sustainability research team.

Laura Garcia Velez joined Lombard Odier in 2020 to advance the development of the company's internal physical risk models. "Understanding the exposure of assets of a company or those in its supply chain to environmental hazards is critical to understanding its risk profile", Garcia Velez says. "We are already seeing rising

risks of wildfire, flooding and extreme weather events and climate scenarios are clear in that these are only likely to increase in the future. Climate action may mitigate some of these, but the tail-end risks can be catastrophic to an individual company."

The team that Garcia Velez is part of is now screening portfolios for their exposure to such physical risks, considering both near-term and long-term risk outlooks, as well as leveraging real-time data when major environmental incidents do occur. “As we understand where assets are located, we may be able to give advance warning when a catastrophe might strike.” As the team has begun to integrate these capabilities, new use cases have emerged. Recently, when a major oil spill occurred in the Artic regions of Russia, the team was able to monitor these developments using remote sensing, providing external verification of the situation and the company’s response to it.

At present, Lombard Odier is pioneering the further development of geospatial models to understand the role that individual companies and their supply chains may play in the context of a growing range of environmental challenges, including deforestation, water withdrawal, biodiversity loss, and agrochemical pollution. Dr Christopher Kaminker, Head of Sustainable Investment Research, Strategy & Stewardship at Lombard Odier believes geospatial analysis is exactly the right tool to tackle these issues. “For a company, assessing exposure to environmental challenges throughout its supply chain can be costly and complex”, Kaminker says. “Remote sensing allows us to directly monitor changes occurring around an asset, including instances of forest loss for any asset, anywhere in the world.”

For Lombard Odier, the insights gleaned from these capabilities do not just help inform investment processes, but also feed into engagement and stewardship activities, helping companies better understand their own exposure. As their expertise in this area grows, so too will the range of issues that they may look at through the new lens of spatial finance.

Case study sponsored by Lombard Odier

UK CASE STUDY:
THE ROLE OF POLICY IN ADVANCING SPATIAL FINANCE

The United Kingdom (UK) Government has a strong ambition to establish the UK as a global leader in the provision of climate and environmental analytics and is taking a cross-departmental approach to achieving this ambition. In late 2020 the Chancellor announced the introduction of more robust environmental disclosure standards so that investors and businesses can better understand the material financial impacts of their exposure to climate change. The UK is the first country in the world to make Task Force on Climate-related Financial Disclosures (TCFD) aligned disclosures fully mandatory across the economy by 2025[15].

The UK Government's Green Finance Strategy sets the objective to align private sector financial flows with clean, environmentally sustainable and resilient growth, as well as strengthening the competitiveness of the UK financial sector. This includes both the provision of green finance and financial data and analytics. Building on its reputation of providing high quality, publicly available environmental and climate-related datasets, and by leveraging recent technology developments, the UK Government is committed to enhancing the quality, coverage and use of geospatial data across all sectors of the economy, including the financial[16].

On the geospatial data side, the Geospatial Commission is responsible for setting the UK's geospatial strategy and coordinating public sector geospatial activity. Its UK Geospatial Strategy for 2020 to 2025 highlights various innovation opportunity areas, including finance, contributing to Government commitments such as net zero greenhouse gas emissions by 2050[17]. The UK Space Agency and leading UK space players have established the Space4Climate partnership, to support a seamless supply chain of climate data from space assets into different sectors. Its climate risk disclosure task group works with the finance sector to facilitate the use of climate satellite data for disclosures and decision making[18].

2021 AND BEYOND

2021 is set to be an ambitious year for climate and biodiversity action. In November 2021, the UK is hosting the 2021 United Nations Climate Change Conference (COP26), which is the first climate change conference since the 2015 Paris Agreement, where countries are expected to commit to enhanced climate ambitions. Countries like Japan, South Korea, China and now the US have joined the EU, UK, South Africa, Chile and others in setting a net zero emissions target[20]. Finance is one of the core campaigns of COP26 as this "race to zero" and long-term transition to a net zero and resilient future requires trillions of dollars of investment and an unprecedented shift in the global financial system[21].

The UN Biodiversity Conference (COP15) in late 2021 will set the direction for the development of a post 2020 global biodiversity framework. It will convene governments from around the world to agree a new set of goals for nature over the next decade through the Convention on Biological Diversity post-2020 framework process, which sets out an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity[22].

As 2021 is set to determine the next decade(s) of climate and environmental action, it is crucial that accurate, consistent and scientifically robust datasets and methodologies are available to inform future finance flows. Given the spatial footprints of the risks, opportunities and impacts associated with the climate and nature crises, we believe spatial finance solutions can and should be scaled up rapidly to support financial decision making.

SPATIAL FINANCE SOLUTIONS CAN AND SHOULD BE SCALED UP RAPIDLY TO SUPPORT FINANCIAL DECISION MAKING

UK CENTRE FOR GREENING FINANCE & INVESTMENT

In April 2021, the **UK Centre for Greening Finance and Investment** (CGFI) was established to accelerate the adoption and use of climate and environmental data and analytics by financial institutions internationally[19]. At the core of CGFI's approach lie spatial analysis and asset-level data. The ultimate vision of CGFI 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 will:

- Co-develop applied research projects with financial institutions that demonstrate the benefits of integrating climate and environmental analytics and produce open risk frameworks, indicators and analytics, underpinned by the best available science and robust translational research.
- Implement an open, interoperable data and e-platform to access, build-off and integrate open climate and environmental data and analytics, from CGFI and others.
- Support an ecosystem of small, medium and large private sector innovators to deliver value-adding analytics and reporting products and services using climate and environmental risk data.

SPATIAL FINANCE INITIATIVE

CGFI
UK Centre for Greening Finance & Investment

This Centre is part of a two staged **Climate and Environmental Risk Analytics for Resilient Finance** programme established by UK Research and Innovation, in direct response to the UK Government Green Finance Strategy and its ambitions to "green finance". It is directly relevant to both the COP26 and the COP15 agenda as programme outputs are expected to deliver information that enhances the resilience of the financial system to the increasing impact of climate and environmental variability.

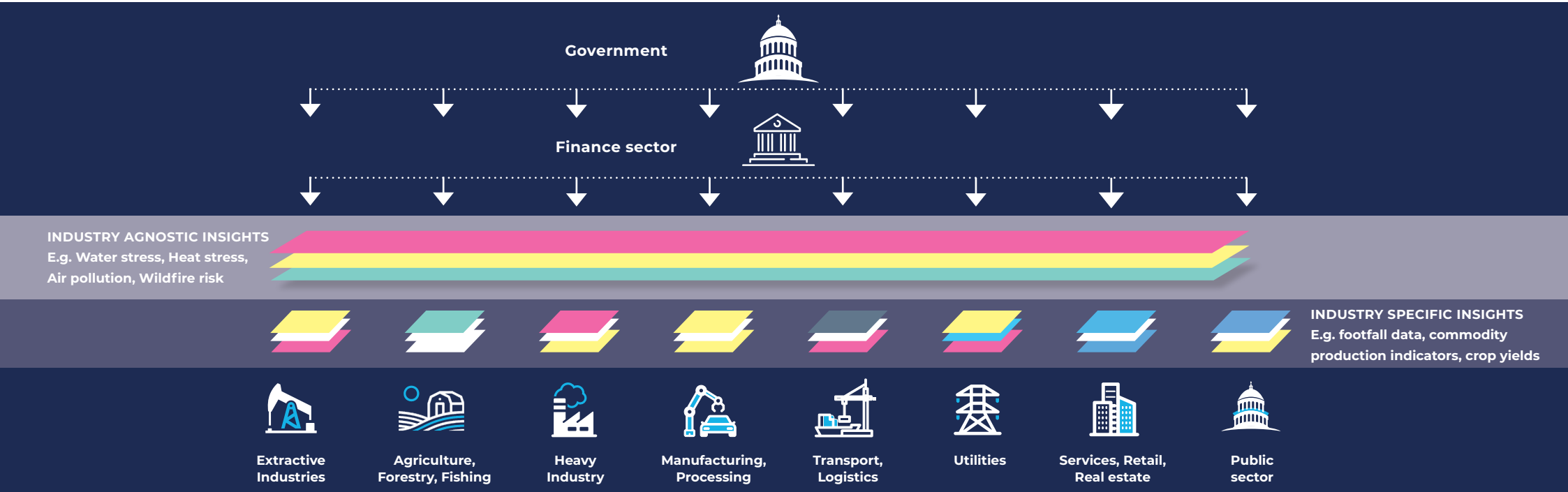
SPATIAL FINANCE APPLICATIONS

Geospatial data can be used in multiple ways and can generate insights that are relevant across industries or are industry specific:

- **Industry agnostic insights:** Exposure of assets, companies and sectors to large, systemic physical issues such as climate change, pollution or environmental degradation can easily be understood with geospatial datasets. E.g., heat stress, air pollution or water availability can be assessed at local, regional or global scale using geospatial datasets.
- **Industry specific insights:** Geospatial datasets can also be used to generate industry or company specific insights and indicators. E.g., footfall data for retail profitability, steel production insights to inform commodity pricing, crop yield predictions for precision farming or tailings management monitoring for mining operations.

Both levels of insight can be relevant for financial institutions to assess risks, opportunities and impacts as they are exposed to all sectors of the real economy.

This section provides an overview of some established and emerging spatial finance applications that are currently available in the market. While this overview is by no means a complete listing of all the available solutions and providers, it aims to show the breadth and capabilities of commercial spatial finance applications to date.



INDUSTRY AGNOSTIC INSIGHTS

PHYSICAL CLIMATE RISK

Financial regulators such as the Bank of England are starting to stress test the resilience of the current business models of the largest banks, insurers and the financial system to climate related risks. Historic, current and future impacts of climate change vary strongly across geographies. With climate change impacting businesses and their supply chains across all industries, it is important to assess spatially the financial risks associated with its physical impacts.

Geospatial information from earth observation (weather, climate, land use, etc.) and human geography (asset location, mobility data) together with forward-looking models, provide information about physical climate risks and impacts at the asset-level. This allows businesses, investors and regulators to assess the impacts of climate related risks and hazards across their portfolios, looking at both chronic trends such as changes in temperature, precipitation or sea levels as well as extreme events such as tropical storms, floods and wildfires.

Blue Ridge fire in Chino Hills California, USA. **Credit:** Planet Labs, CC BY-NC 2.0

Geospatial Added Value

- High resolution datasets allow for granular, bottom-up analysis.
- Global geospatial datasets allow for comparison of risk exposure across assets, companies and geographies.

Examples

Asset Resolution's forward-looking database of physical assets matched with securities supports both physical and transition climate risk analysis across key industries.

The **Cross Dependency** Initiative physical climate risk platform is being used to support physical risk quantification in a climate risk **framework** for TCFD reporting with Legal & General Investment Management and Baringa Partners.

Jupiter Intelligence provides asset-level risk analyses and probabilistic predictions over multiple time periods into the future.

Sust Global's geospatial platform allows users to quantify climate-related risks to mitigate forward-looking losses and support disclosure and reporting.

NATURE AND BIODIVERSITY RISK

There is increasing awareness of the (financial) value that nature and biodiversity create either directly or indirectly for all economic sectors. The decline of biodiversity and natural ecosystems can thus be considered a source of financial risk, and one that is inherently spatial.

Geospatial and earth observation datasets provide insights into different types of nature and biodiversity risks, impacts and opportunities linked to land use changes:

- Attribution of ecosystem degradation (extent and quality) to its economic actors or drivers.
- Monitoring of economic activity in or around protected areas or compliance with environmental regulations.
- Identification and monitoring of nature restoration investment opportunities.

Zambezi Delta wetlands, Mozambique. **Credit:** European Space Agency, CC BY-SA IGO 3.0

Geospatial Added Value

- Cost-effective monitoring of financial or reputational risks at company, portfolio or ecosystem level.
- Transparent source of information where no disclosed information is available.

Examples

Ecometrica's environmental and climate risk monitoring platform allows users to analyse environmental risks such as deforestation, water and biodiversity across their assets, suppliers and sourcing regions globally.

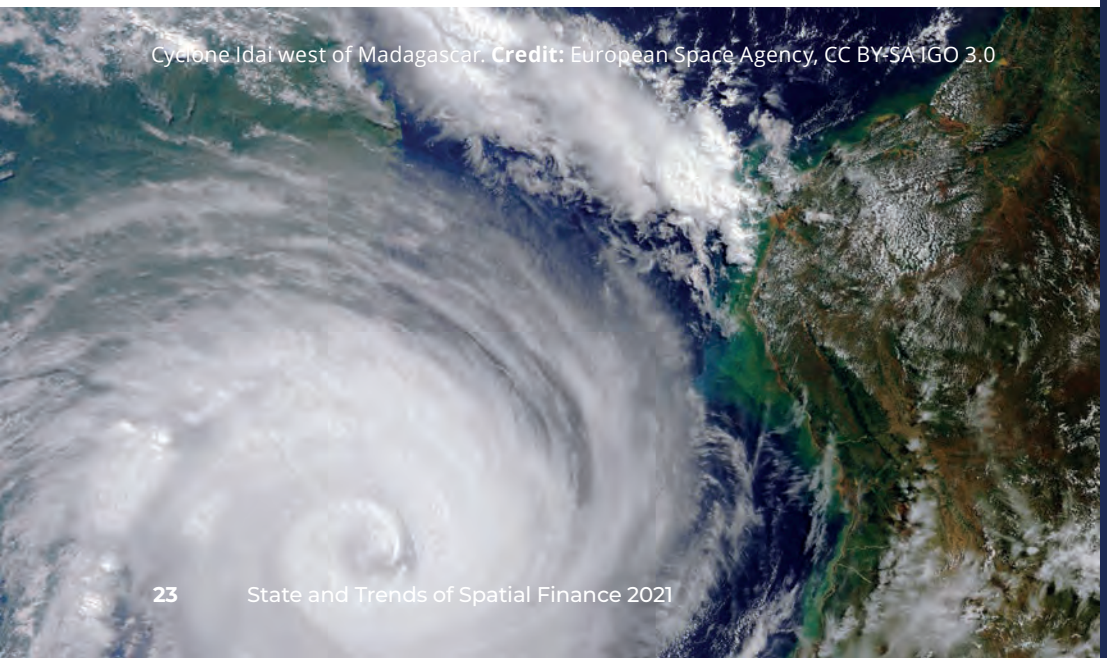
NatureMetrics' environmental DNA technology allows businesses and projects to monitor and report on their biodiversity impacts in an easy and low-cost way by collecting data on hundreds of species from a single water or soil sample.

Ninety One's **Climate and Nature Sovereign** Index incorporates geospatial data and forward-looking projections about natural assets on a country level to inform sovereign debt investors about sustainability-related risks and growth opportunities.

NATURAL CATASTROPHE (RE)INSURANCE

The insurance sector has traditionally been an early adopter of geospatial technologies, particularly for natural catastrophe products providing insurance cover against natural hazards across industries:

- Natural catastrophe modelling and underwriting relies on geospatial datasets as inputs to provide more accurate assessments of clients' exposure and therefore their own potential losses based on geographic exposure.
- Real-time disaster monitoring based on weather data or spatially tagged social media posts can help insurers to implement appropriate interventions, assess the scale of potential losses and make the necessary funds available.
- Post-disaster damage assessment using drone or satellite imagery offers a scalable way to rapidly manage large volumes of claims and accelerate payouts for insurance **holders.**



Cyclone Idai west of Madagascar. **Credit:** European Space Agency, CC BY-SA IGO 3.0

Geospatial Added Value

- Improved insight into risk, leading to better management of accumulated risk.
- The ability to set more appropriate and competitive pricing at individual customer level.
- A faster response to major incidents, improving customer service.

Examples

Fathom creates high resolution global or national flood hazard models based on transparent methodologies and academic research from the University of Bristol.

McKenzie Intelligence uses earth observation data to assess post natural catastrophe damage and functionality levels at the property level.

Willis Towers Watson uses location intelligence in catastrophe modelling to provide more accurate assessments of clients' exposure and their own potential losses based on geography. The modelling is now enhanced by population demographic and socio-economic data and assessing proximity to other insured locations to model aggregated risk.

SUPPLY CHAIN MONITORING

With many industries relying on global supply chains, companies and their financiers are becoming increasingly exposed to supply chain disruptions or scandals causing financial and reputational damage. Geospatial analysis can support the mapping and monitoring of supply chains, while ledger technologies such as blockchain allow for increased supply chain traceability.

Geospatial supply chain modelling allows for the prediction of bottlenecks and risks across a wide range of issues:

- Weather or climate-induced events disrupting trade routes or production yields for crucial product inputs.
- Environmental impacts such as deforestation, land degradation or pollution, linked to the production of input materials.
- Human rights issues and ethical sourcing linked to suppliers' labour practices.

Palm oil plantations in Borneo, Indonesia. **Credit:** European Space Agency, CC BY-SA IGO 3.0

Geospatial Added Value

- Intuitive visualisation of complex global supply chains.
- Scalable risk assessments to support engagement or reporting activities.
- Cost-effective monitoring of compliance against internal policies, legal frameworks or (science based) targets.

Examples

A **partnership** between blockchain technology provider **Provenance** and **Sourcemap** enables supply chain tracking and claim verification in the food and fashion industries.

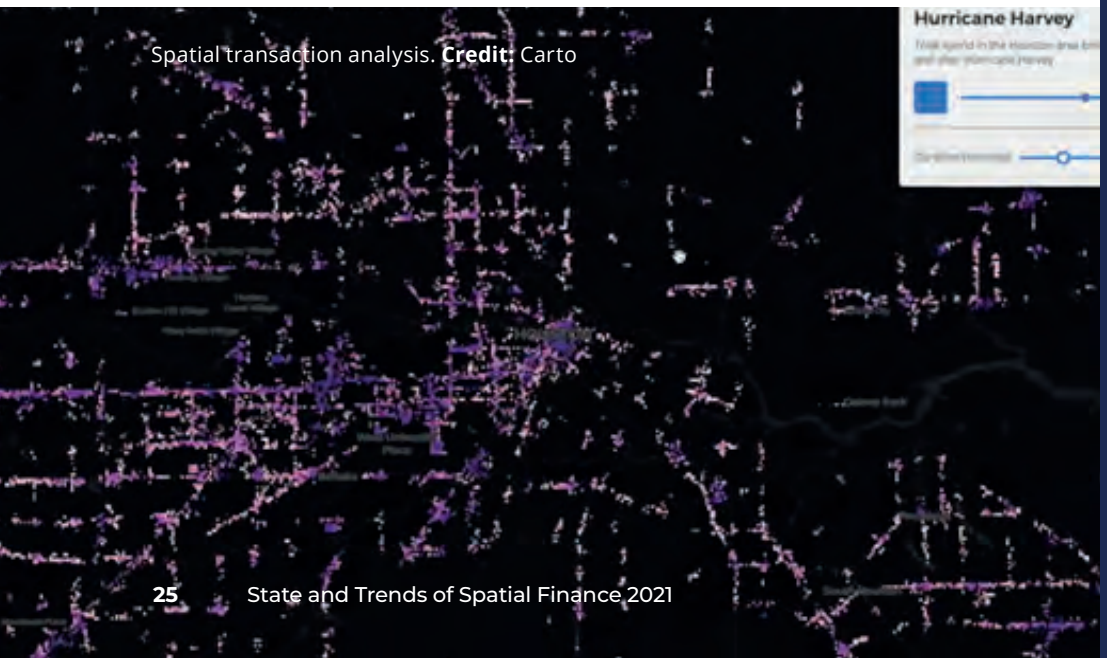
Satelligence's satellite and AI powered tools monitor deforestation in near real-time, which supports an asset manager led engagement **programme** on deforestation-free supply chains.

TRASE's tools show how consumer countries and financial markets are exposed to environmental and social risks in agricultural commodity supply chains by linking consumption to the locations of production through commodity traders and intermediaries.

DIGITAL IDENTITY VERIFICATION

Meeting statutory obligations in an increasing digital and complex environment to avoid breaching trade sanctions or anti money-laundering or national compliance regulations, requires a detailed view of the geography of transactions, customers and the business. Geospatial analysis can reduce the risks inherent in each transaction by improving knowledge of exactly who the organization is doing business with and where, and find correlations between locations and other transactional signals. Some examples of transactions include:

- Payment transactions
- Real estate and property transactions
- Customer onboarding



Spatial transaction analysis. **Credit:** Carto

Geospatial Added Value

- Simplified and intuitive screening of risks or opportunities.
- Avoid non-compliance fines and other business-limiting sanctions.
- Reduction in time and cost associated with Customer Due Diligence (CDD).

Examples

Experian uses increasing volumes of geospatial data to help individuals and businesses get fairer, faster access to essential financial services.

The **Financial Action Task** Force recommends the use of location intelligence for digital identification checks and transaction monitoring24.

The **Singaporean Government** is developing a digital identity service (MyInfo) for digital transactions with the Government and private sector. Singaporean financial institutions now use MyInfo to onboard and perform CDD on customers.

INDUSTRY SPECIFIC INSIGHTS

COMMODITY TRADING INTELLIGENCE

Commodities are typically produced, traded, shipped and consumed globally. Geospatial data can provide traders of soft and hard commodities with near real-time information about (expected) production outputs, cargo in transit or drivers of demand. Commodities that are typically monitored by geospatial service providers include:

- Agricultural: Corn, soy, maize, coffee, etc.
- Energy: Oil, gas, renewables, etc.
- Metals: Steel, Copper, Aluminum, etc.

The same type of data and analysis is also used to extract general business intelligence around footfall in retail, economic growth and manufacturing, construction and logistics activity at the asset, regional, or company level.

Geospatial Added Value

- Competitive edge for commodity buyers, sellers and intermediaries through access to information before official statistics are released.
- Source of information and pricing signals in otherwise opaque markets and geographies.

Examples

ChAI leverages artificial intelligence and alternative data sources to create impartial materials and energy price predictions.

Geospatial Insight monitors retail, industrial and energy locations in near real time using drone, aerial and satellite imagery to provide the basis for better decision making.

Orbital Insight uses optical and radar satellite imagery to calculate inventory volumes for above ground oil storage tanks across 26,000 tanks globally.

Oil storage nears capacity in Oklahoma, USA. **Credit:** Planet Labs, CC BY-NC 2.0

REAL ESTATE DUE DILIGENCE

Globally, real estate is the largest asset class. However, investment decisions are often still made based on fragmented and incomplete valuation data. Consequently, real estate markets are inefficient and overly volatile.

A lot of the data required to make better decisions in both residential and commercial real estate sectors is geospatial in nature, including land titles, planning permissions, local amenities, access to transport, neighbouring properties, environmental factors such as air pollution, etc.

A new class of software platforms and analytics are emerging that collate, analyse and validate data from multiple sources to underpin site finding, valuation, competitor analysis, financing and meeting regulatory development compliance.

Examples

Airbus Intelligence provides integrated earth observation, address and perils data to support UK retail banks' real estate risk management.

FTSE Russel has designed the **FTSE EPRA Nareit Green Indexes** building on **GeoPhy** geolocation datasets to assess the sustainability characteristics of real estate portfolios.

Orbital Witness's geospatial tool automates risk profiling in land and property transactions for insurers and law firms.

Apple's Cupertino Campus under construction, California, USA.
Credit: Planet Labs, CC BY-NC 2.0

Geospatial Added Value

- Faster decision making for lending and insurance through ready access to evidence at a property or portfolio level.
- Lower cost desktop surveys instead of sending surveyors on-site.

AGRICULTURAL FINANCIAL PRODUCTS

Agriculture is a sector where the use of earth observation data and geospatial technologies is well established for predicting crop yields, detecting pests and optimising harvests. These same datasets can show yield and productivity trends over time, providing historical indicators of (financial) risk on a field-by-field or farm-by-farm basis.

Financial institutions are starting to use these datasets to generate risk profiles for agricultural clients in emerging markets where other historical risk information is not easily accessible. These analytical tools are increasingly being developed by start-ups and entrepreneurs in emerging markets (e.g. Kenya, India or Brazil), supporting access to (micro) credit and insurance thus bringing protection and financial stability to millions of overlooked smallholder and SME businesses worldwide.

Examples

Apollo Agriculture leverages satellite data and machine learning to inform credit decisions and automated operations to help small-scale farmers.

Mantle Labs' agriculture platform provides historic and current crop health indicators on a daily basis at a global scale, which is used in credit risk scores, crop insurance underwriting and index-based claims processing.

Pula designs and delivers agriculture index insurance products for smallholder farmers in developing countries by leveraging digital data to support end-to-end management insurance delivery to farmers.

Rice growth evolution, Vietnam. **Credit:** European Space Agency, CC BY-SA IGO 3.0

Geospatial Added Value

- Financial product creation in new markets where historical credit data is not readily available.
- Cost-effective underwriting and claims management for small and medium-sized clients.

ESG RISK AND IMPACT ASSESSMENT

Geospatial datasets provide insights into companies' environmental, social and governance (ESG) performance around specific issues that are material for each industry. They offer an effective means of monitoring impacts or risk and how they change over time at the asset level.

Many ESG issues are industry specific and have a spatial element which can be better understood using geospatial data. The translation of geospatial datasets or observed trends into indicators of financial risk is still in its infancy but offers great potential. Some existing solutions cover:

- Production and raw materials usage indicators for heavy industry.
- Land and water usage or renewable energy deployment.
- Attribution of methane emissions to individual oil and gas operators.

Geospatial Added Value

- Early assessment of potential physical, transition or liability ESG impacts and risks.
- Scalable data collection allows assets or companies to be compared across their industry even where disclosures are lacking.

Examples

Geofinancial Analytics attributes satellite-observed methane emissions to individual oil and gas well operators and presents this information in normalised risk scores.

OceanMind leverages satellites and artificial intelligence to monitor fisheries compliance and illegal, unreported and unregulated fishing activities for authorities and seafood buyers globally.

RS Metrics uses satellite data to uncover operational and environmental trends, predictive signals, ratings and alerts for thousands of industrial assets owned by public companies to offer ESG insights through web application or APIs.

Oil spill in coral reef, Mauritius. **Credit:** Planet Labs, CC BY-NC 2.0

ENVIRONMENTAL MARKETS

Geospatial datasets can support the creation and running of environmental markets by providing near real-time environmental information at scale. This data is relevant to understand the availability or supply of environmental services and monitor changes over time. It complements in situ measurements or manual inspections in terms of frequency, cost and scale.

Smart contract technologies such as blockchain are being leveraged by various organisations to create or underpin environmental credits or offsets (e.g. carbon, biodiversity, water) generated by regenerative land use practices. Using geospatial datasets as a verifiable data source, these new instruments ensure the quality and transparency needed to scale up carbon offset markets in a cost-effective way.

Examples

Regen Network's blockchain technology for verification of claims, agreements and data related to ecological state underpins carbon credits for the restoration of natural grassland systems.

SilviaTerra's high resolution forest inventory underpins a natural capital exchange where landowners receive payment to reduce timber harvests.

Sylvera is developing remote carbon stock evaluation analytics for voluntary carbon offset markets.

Commercial forestry in Tasmania, Australia. **Credit:** Planet Labs, CC BY-NC 2.0

Geospatial Added Value

- Reduced monitoring, reporting and verification costs allow more and smaller players to access environmental markets.
- Verifiable datasets allow for transparent verification of environmental impacts, reducing risks of greenwashing.

PARAMETRIC INSURANCE PRODUCTS

Parametric or index-based insurance payouts are triggered by reference to an index/threshold rather than an assessment of actual losses under more traditional insurance schemes.

Parametric insurance is suited for low-frequency but high-intensity losses as in catastrophic perils, weather-related risks in agriculture or other economic activities, and risks without sufficient history of losses captured as insurance-readable data. Products can be created to cover industry-specific assets as well as specific perils.

Rigorous parameters need to be independent, verifiable and frequently reported. Geospatial data, when provided in a consistent and independent way, can feed into the parameters used to set up and settle parametric insurance products. They are particularly relevant for events such as cyclones, drought or floods.

Geospatial Added Value

- Creation of insurance products in emerging markets where consistent, historic datasets are not easily accessible.
- Low cost, scalable and transparent monitoring of parametric triggers.

Examples

Global Parametrics' risk hazard platform assesses extreme climate and natural disaster risk globally to build customised impact indices which can be structured into financial solutions.

Swiss Re, in collaboration with **Vandersat,** has developed a **soil moisture deficit index insurance** to protect farmers against the financial losses of drought, where payout is based on the daily soil moisture data from satellite EO sensors.

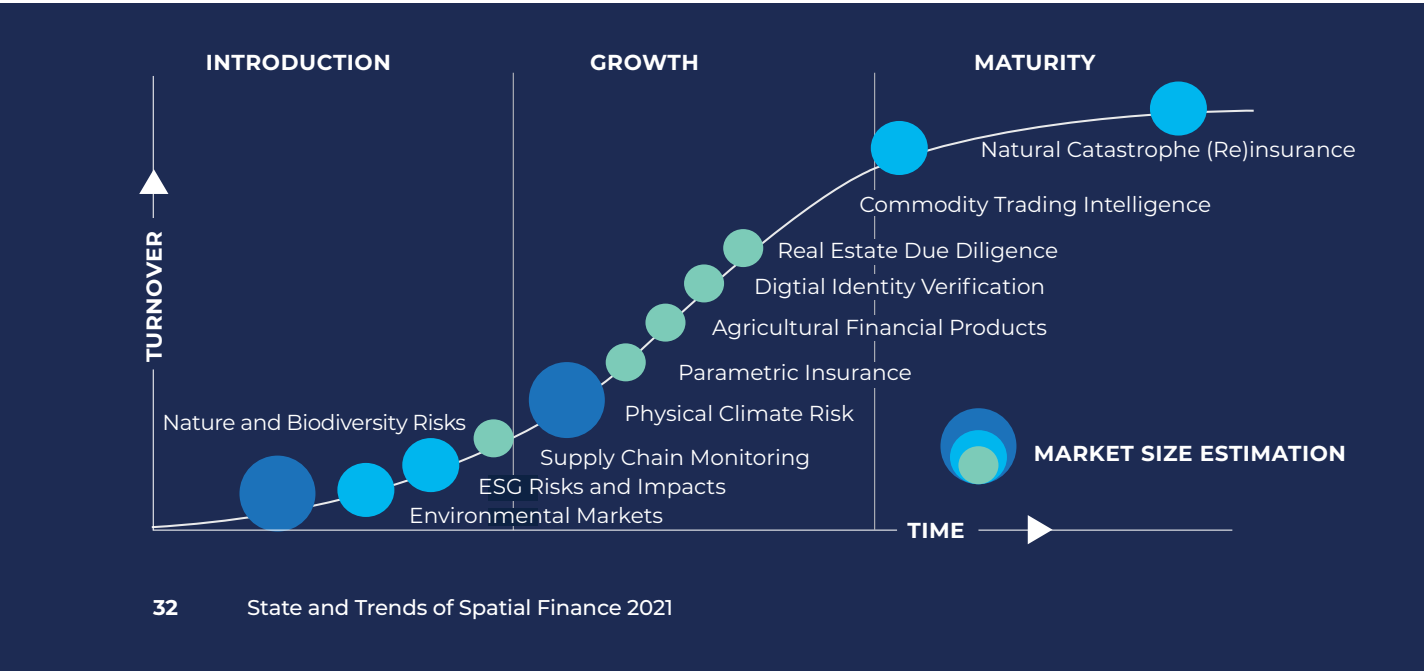
The World Bank and ASEAN+3 have established the **Southeast Asia Disaster Risk Insurance Facility**, which combines detailed geospatial exposure data with satellite observations of flooding to trigger funds for early disaster response.

Severe flooding in Louisiana, USA. **Credit:** Planet Labs, CC BY-NC 2.0

MATURITY AND POTENTIAL

Geospatial solutions are widely used in most industries (e.g. mining, agriculture, transport) to optimise operations. Within the financial services sector, geospatial applications can support both operational processes (e.g. underwriting, claims management, transactions) as well as provide insights into the performance, risks or opportunities associated with investments and financial products. The operational applications, particularly within insurance and commodity trading, are most mature but the potential for growth across other sectors of the financial system are huge. Many new applications have become available only over the last couple of years, with significant potential to scale as both climate and environmental considerations are becoming mainstream within the financial sector.

The figure below plots the applications outlined in this report against their maturity and addressable market size to give an idea about their potential to scale. While not each type of application necessarily represents a market, and some of the applications overlap, each of these are at different levels of maturity and have a different addressable market size as they are relevant for different types of financial institutions or financial asset classes. This assessment is based on publicly available information from over 300 geospatial service providers and the authors' understanding and expertise of the geospatial market.



In summary, we have seen strong adoption of geospatial data and technologies for natural catastrophe (re)insurance (modelling, monitoring and claims management) and commodity trading intelligence applications. These are characterised by a proven business case around cost savings, new product creation and better market pricing information. Increasing interest in climate, environmental and social issues is driving new spatial finance applications in these areas. The market for these is likely to grow significantly as the financial implications of these issues become better understood and regulation around disclosure and risk management come into play. Other prerequisites for growth include the wider availability of asset-level data and better translation of geospatial insights into financial risk, impact and opportunity metrics across all sectors.

FUTURE OF SPATIAL FINANCE

The growth of spatial finance is likely to accelerate over the next couple of years as existing geospatial technologies and applications are applied to new use cases, as new and complementary datasets are integrated and a whole range of innovative functionalities and applications become available.

FUTURE USE CASES

Spatial finance techniques and datasets allow for a more fundamental and comprehensive understanding of risks, impacts and opportunities across many untapped financial sector use cases.

Stress Testing

Financial regulators and large financial institutions can understand the diffusion of current and future climate and environmental risks across the financial system by connecting the financial system with the real economy from a physical asset level upwards.

Liability Risk Assessment

Insurers or asset managers can assess exposure to, and assign liability for, failure to mitigate, address or disclose a wide range of climate or environmental related risks and impacts.

Active Ownership and Engagement

Reduced information asymmetry between investors and company executives will allow for more targeted, proactive, and impactful engagements between investors and the companies in their investment portfolios, leveraging near real-time data and forward-looking models to challenge corporate statements and mitigation strategies.

Portfolio Management

Spatial finance techniques can unlock sophisticated analysis and competition among passive and active investment managers, creating opportunities for higher risk-adjusted returns.

Monitoring Policy Implementation Progress

Asset-level data allows policymakers, civil society and investors to track progress on policy implementation in a bottom-up way, identifying leaders and laggards with regards to e.g. the Paris Agreement, Sustainable Development Goals, or the Convention on Biological Diversity.

Verification of Corporate Disclosures

Investors, regulators, or civil society organisations can use spatial finance to verify corporate disclosures and hold corporates to account on various environmental challenges.

Mission-Aligned Investing

Transparency allowed by asset-level data and geospatial analysis can help asset owners and their asset managers identify investment opportunities that are aligned with the asset owners' mission and reduce exposure to investments that are not.

FUTURE DATASETS

Many geospatial datasets that are currently used across industries remain untapped for financial sector applications such as maritime and mobility data, IoT sensor data or climate models. As these datasets improve and become more adapted to financial sector requirements, spatial finance applications will become ever richer.

Mobility and Transport Data

In the maritime sector the Automatic Identification System (AIS) is an automated tracking system that displays the location of vessels. Analysis of movement patterns and “disappearances” can be used to identify nefarious activities such as piracy and illegal fishing. Onshore, connected, and autonomous cars and rideshare platforms, such as Uber, will capture vast quantities of spatial data that will allow operators to build near real-time maps of large swaths of the planet. The World Bank Open Transport initiative is a showcase[23]. In the air, planned flight tracks for drones are already being combined with meteorological and flight restriction data to write insurance policies[24].

Internet of Things

IoT encompasses everything connected to the internet, but its significance here is in its use in relation to objects that "talk" to each other. The management of the smart city of the future will depend on the output from such sensors, whether it is monitoring car parking spaces, ensuring safety or solving crime. Conflation of multiple IoT and other locationally aware data sources and analysing them with AI based software will become increasingly important[25].

National Statistics

The COVID-19 pandemic has shown the role that spatially referenced statistical data plays in decision making. From the definition of lockdown areas to pinpointing super spreader events the linking of highly granular spatial intelligence to social demographics has been highly effective particularly in East Asian countries such as South Korea[26]. These techniques of analysis can be generalised to inform policy decisions such as access to health care and microfinance.

Input-output tables are created by national statistics offices and can be used to understand interdependencies between different sectors of a national economy or different regional economies. One example is the Eora global supply chain database which consists of a multi-region input-output table model that provides a time series of high resolution IO tables with matching environmental (e.g. carbon, water, air, nitrogen) and social (e.g. labour) accounts for 190 countries[27]. Combining these with geospatial datasets could generate additional scalable, high resolution insights.

Unknown Unknowns

A more general trend is that the abundance of data is increasing exponentially. The human armed with a smartphone is a powerful sensor creating many novel sources of information that are spatially referenced. The serendipitous effects of exposing the financial sector to such advances will produce unexpected new use cases. Neither the geospatial profession nor the finance sector alone will recognise the value of these examples but working together they will discover applications that may change our world fundamentally.

FUTURE APPLICATIONS

As blockchain and AI technologies continue to develop and mature, currently niche spatial finance applications will be able to scale. This will reduce information asymmetries and drive transparency across climate and environmental, social and governance (ESG) risks, opportunities and impacts.

Geospatially Enabled Smart Contracts

Geospatially-enabled smart contracts where ecosystem service credits or offsets (e.g. carbon, water, biodiversity) are created or verified using geospatial data and ledger technologies, can ensure the quality and transparency needed to scale up offset markets in a cost-effective way.

Near-real Time ESG Risk and Impact Dashboards

Near real-time ESG risk and impact indicators or dashboards, monitoring ESG issues material to specific industries with near real-time data sources, can inform investors of potential liabilities or breaching of commitments and policies early on.

Predictive Analytics

Predictive analytics combining forward-looking models with observed historical impacts under specific physical conditions can provide insights on how future climate conditions will impact specific locations and the assets reliable on its environmental resources.

DRIVE TRANSPARENCY ACROSS CLIMATE AND ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) RISKS, OPPORTUNITIES AND IMPACTS

DIGITAL FOOTPRINT OF GLOBAL ECONOMY

A key enabler for spatial finance is access to accurate and trusted global datasets of physical assets in every major sector of the global economy. We need to know where assets are, their characteristics, and who owns them. Using geospatial data and AI techniques, as well as natural language processing to track changes in ownership, we can now sequence or decode the real economy.

In a manner that is analogous to the Human Genome Project, it is now possible to produce universally trusted, transparent, and verifiable datasets covering every asset in the global economy[28]. By the end of the decade, we can sequence every sector of the global economy and have successfully distributed (and maintained) the associated asset-level datasets. A Global Asset Transparency Project would drive innovation in the process of mapping asset and ownership structures, and then unleash a vast array of opportunities and applications once the data becomes publicly available. This would greatly enhance the ability of financial institutions and other actors to align their portfolios and strategies with climate and other environmental objectives, as well as manage risk.

COP26 provides the UK and other international governments with the perfect platform to support such a Global Asset Transparency Project, overcoming market failure and coordination barriers as with the Human Genome Project. The provision of a baseline of publicly available asset-level data can address the collective action problem currently facing the financial industry and help make the development of applications on top of this data commercially attractive. This could lead to significant public-good benefits and increased transparency, not only for financial actors but also for businesses, civil society and policymakers.

Early leadership in spatial finance will allow UK-based firms to shape the future applications and grasp the commercial opportunities, while contributing significantly to the UK's own climate goals and those of the international community. This digital footprint of the global economy will underpin many of the use cases and future commercial applications outlined in this report, as well as building on the ever-improving technology advances in EO and data science.

ANALOGOUS TO THE HUMAN GENOME PROJECT, IT IS NOW POSSIBLE TO PRODUCE UNIVERSALLY TRUSTED, TRANSPARENT, AND VERIFIABLE DATASETS COVERING EVERY ASSET IN THE GLOBAL ECONOMY

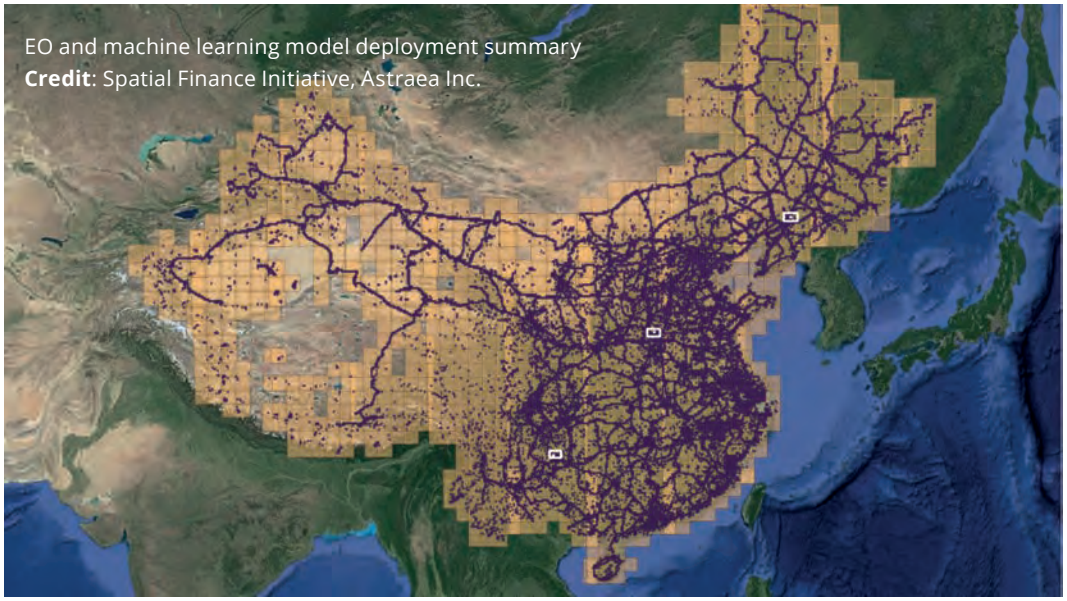
CASE STUDY: OPEN ASSET-LEVEL DATA FOR CEMENT AND STEEL SECTORS

In 2021 the Spatial Finance Initiative (SFI) is launching two open global asset-level datasets for the cement and iron & steel sectors, providing information about individual facility geolocation, ownership, capacity, production process and age.

The GeoAsset project team used 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.

Cement and iron and steel production are two of the most emission-intensive industries in the world, with significant environmental impacts beyond carbon. A global transition strategy to environmental sustainability, including net-zero by mid-century, requires a complete understanding of these sectors.

CEMENT AND IRON AND STEEL PRODUCTION ARE TWO OF THE MOST EMISSION-INTENSIVE INDUSTRIES IN THE WORLD



EO and machine learning model deployment summary
Credit: Spatial Finance Initiative, Astraea Inc.

New Plant **Known Plant** **False Positive**

CONCLUSION

Spatial Finance Today

Advancements in geospatial data collection and data processing technologies are driving unprecedented insights into a wide range of risks, opportunities and impacts across all economic sectors. While these technologies are supporting operational insights across these sectors there is a significant untapped potential within the financial sector.

Mature spatial finance applications exist in natural catastrophe insurance and commodity trading. These are currently characterised by a disconnect in ownership between the insurer or trader and underlying asset and the relatively short-term pricing or trading decisions they support. Spatial finance applications looking at physical climate risk, supply chain sustainability and environmental impacts are becoming available only relatively recently.

Better access to asset-level data, tying physical assets and their exact location to ownership structures, is needed to scale these up across all sectors of the real economy and its derived financial products. This will make the wealth of spatial finance applications and the information available in geospatial datasets and its derived climate or forward-looking models, significantly more actionable for medium-to-long-term financial decision making.

Scaling up Spatial Finance

Continuous advancements in data processing technologies such as AI, specifically machine learning, computer vision and edge computing, will enable dynamic and timely spatial analysis at the scale that is required for financial decision making in a global economy. Smart ledger technologies and predictive modelling capabilities will expand spatial finance applications to environmental markets and forward-looking analytics. Increased availability of asset-level data will make spatial data more actionable, while at the same time existing environmental and climate datasets will be translated in more suitable indicators for financial sector use.

Future of Spatial Finance

As technologies mature and more sophisticated applications become available, the use cases for spatial analysis in finance will expand rapidly across different actors. Asset managers and banks will be able to make decisions, manage and report on ESG risks in a much more granular way. Asset owners will be able to align investment portfolios with their mission and engage with investees in a much more proactive and informed way. Regulators and civil society organisations will be able to verify corporate disclosures or monitor progress against policies and commitments.

ABOUT THE AUTHORS

SPATIAL FINANCE INITIATIVE

The Spatial Finance Initiative (SFI) has been established by the Alan Turing Institute, Satellite Applications Catapult, and the University of Oxford to bring together research capabilities in space, data science and financial services and make them greater than the sum of their parts. SFI was set up to mainstream geospatial capabilities into financial decision making globally. The initiative is committed to promote and grow the wealth of spatial finance applications and opportunities and will achieve its vision through the following activities.

Creating Open Asset-level Datasets

Reliable and consistent asset-level datasets tying physical and natural assets to ownership structures are required to deliver a step change in accountability and transparency. The advances in EO and AI make it possible to create trusted, transparent, and verifiable datasets of every asset in the global economy, mapped against its ownership structure. SFI's GeoAsset project will drive the creation, access to, and improvement of, publicly available asset-level datasets, tying physical assets and their location to ownership for high impact industries.

Upskilling and Capacity Building

To fully capitalise on the added value of geospatial technologies, new skills will have to be embedded across financial institutions' teams and functions. SFI and its partners are committed to educating and training financial practitioners in the use and relevance of spatial finance datasets and analysis techniques.

Promoting Applied Multi-Disciplinary Collaboration and Research

Through active engagements with the financial and geospatial sectors, SFI will identify latent and future spatial finance use cases. It will bring together capabilities in data science, geospatial technologies, and finance to stimulate multi-disciplinary academic and commercial research or proof of concepts.

The Spatial Finance Initiative is part of

CGFI
UK Centre for Greening Finance & Investment

SATELLITE APPLICATIONS CATAPULT

The Satellite Applications Catapult is a unique technology and innovation company boosting UK productivity by helping organisations harness the power of satellite-based services. The Catapult achieves this by exploiting the innovation potential in the UK industrial and academic communities, by being a focal point where small and medium enterprises, large industry and end users can work together with researchers to challenge barriers, explore, and develop new ideas, and bring these to commercial reality.

CONSULTINGWHERE

ConsultingWhere is an independent spatial strategy consultancy, based in the UK but operating worldwide. The organisation has grown substantially over its 12 years of operation, with successful assignments undertaken throughout Europe, the Middle East, Africa, Asia, the Caribbean and Australasia. The company has 20 professional staff and associates and strategic partnerships with similar consultancies in Europe, Southern Africa and Australia to further extend its global reach.

The contributing authors, Andrew Coote and Simon Wills, bring over 40 years of experience in geospatial data management and earth observation, including customers in Central and Local government, International Financial Institutions, Energy, Land and Property and Environmental Management sectors.

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