D1.2 GEO-INFORMATION REQUIREMENTS REPORT

EO-FIN

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Code:	D1.2
Version:	1.0
Date:	29/06/2023
Internal code:	23284/23 v1/23

DOCUMENT STATUS SHEET

Version	Date	Pages	Changes
0.1	27/02/2023	34	
1.0	29/06/2023	59	Improved Section 4: Summary of desk based research findings. Expanded Section 2: Methodology overview Completed Section 6: Interview findings Completed Section 7: Consolidated User Requirements Drafted Section 8: Conclusion Added Annex B

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1. EXECUTIVE SUMMARY

This report summarises the findings of a research project aimed at gathering key user needs, challenges, and geo-information requirements of the Financial Management (FM) sector. Four FM domains were considered:

- **Investment Management** as an industry is highly diversified, with a focus on the allocation of client capital across a wide range of asset classes and investment strategies. This capital is entrusted to investment managers who invest on a client's behalf to deliver a return on their client's capital, mitigate risk, or to deploy that capital in line with particular principles/ethical frameworks. Increasingly common are constraints which take into account ESG considerations, which may be accompanied by associated due diligence and reporting requirements.
- **Green Finance** is defined such that it includes structured financial activities, products, or services, that have been created to mitigate negative impacts that arise from environmental pollution and climate change. The funded interventions seek to foster the development of greener business practices, operating models, and a sustainable economy as a whole.
- **Risk Analysis** includes the process of identifying, assessing, and managing financial, legal, strategic and security risks to an organisation's capital, operations, and earnings. Financial Management businesses typically have a Risk Management function to ensure they identify risks to their operations and manage these risks, in order to mitigate exposure and impact.
- **Insurance Management** is defined as the section of the finance industry that provides risk management solutions in the form of insurance contracts. Insurance contracts serve as a hedge against uncertain or contingent losses to assets or occurrences which may impact business operations.

Each of these four domains are highly dependent on information to efficiently act as part of the broader financial ecosystem. Geoinformation is increasingly viewed as one source of alternate data to drive further improvements across these domains.

To obtain the most recent and relevant information directly from Financial Management professionals, four distinct activities were undertaken.

- An extensive desktop review was conducted to examine geospatial data in the financial sector, identify the drivers behind the demand for spatial finance, and pinpoint potential stakeholders
- A workshop was organized to gather feedback, thoughts, and valuable contacts from FM stakeholders
- A series of semi-structured one-to-one interviews were carried out with stakeholders from the private, public, and third sectors to unravel and gain a deeper understanding of geospatial pain points, opportunities, as well as user needs and requirements
- A synthesis task was carried out to consolidate the gathered information, improve it via the review of a Stakeholder Board review process, and report it publicly for further comment and dissemination of useful findings

These findings were used to generate a consolidated User requirements database, which presents the expressed user needs. In addition to expressed user needs, a few overarching themes became apparent during the activity. Below we describe the most important observations in this vein.

- **Security around corporate secrets**
  - Many of the Financial Management professionals invited to participate in this project explained that they were unable to do so on account of internal corporate policies regarding sharing information on their data sources, analysis methods, and projects to improve business processes. Corporate secrets, especially those from which a company derives a significant benefit, are jealously guarded. This is reflected in our information sources, with some bias towards institutional organisations who are more open in this regard, and hence likely some bias toward the same organisations' perspectives in our findings. This lends further support to the importance of the sharing of best practices uncovered as part of this project.
- **Needs bounded by known constraints**
  - Among those willing to speak candidly, the researchers discovered a strong tendency to base statements about geoinformation product and service needs on their knowledge of technical possibility. This (likely subconscious) restraint meant that it was particularly difficult to elicit

user needs that centre on geoinformation products and services that do not currently exist in the market. The result was a bias towards responses that focus on aspects of needs aside from technical capabilities.

- **Skills and training**
  - Chief among the non-technical user needs expressed was a way to bridge the current skills gap that exists between the Financial Management sector and geoinformation. Stakeholders identified a lack of an existing skills base, inadequate training material, limited financial resources to fund staff development, and a significant demand for 'pre-processed' and 'insight-ready' geoinformation to sidestep these issues in the short run.

This report is intended to enable the wider EO industry to tailor their development of products and services to real user needs and pain points, as identified throughout. A further analysis of the current challenges of users and the corresponding EO capabilities that exist today and in the near-future will be provided in a future deliverable from this same project. This future report will link challenges to capabilities and also identify gaps in the current EO capabilities portfolio.

2. INTRODUCTION

EO-FIN, an European Space Agency (ESA) project seeking to understand how, and under what conditions, the Financial Management sector can best benefit from geospatial data. This geospatial data, referred to more generally as 'geoinformation', includes satellite-derived Earth Observation (EO) data. As part of developing this understanding, the project seeks to identify Financial Management industry user requirements for geoinformation, understand associated EO capabilities that can (potentially) meet these requirements, and assess the gaps that exist between requirements and technical feasibility.

The Financial Management sector was assessed across four markets:

- Investment Management: services including asset allocation, stock allocation, monitoring of existing investments, and portfolio strategy and implementation.
- Risk Management: the process of identifying, assessing, and managing financial, legal, strategic, and security risks to an organisation's capital, operations, and earnings.
- Insurance Management: services including the provision of insurance contracts, underwriting, ongoing and post-event asset evaluation, and claims against policies.
- Green Finance: financial activities that mitigate negative impacts that arise from environmental pollution and climate change, and support development of a greener future.

EO-FIN's first Work Package, **WP100**, entailed the collection and consolidation of detailed geoinformation requirements for business processes. Specifically, the aim of the first task was 'to gather detailed geoinformation requirements for business processes as a precursor to defining associated EO capabilities and assessment of the capability gaps associated with these requirements. The geoinformation requirements were gathered via desk-based research, a workshop to gather user requirements, and semi-structured follow-up interviews with key industry stakeholders.

This document ("Geo-Information Requirements Report D1.2") aims to summarise the main challenges in the Financial Management sector; outline its current use of geo-information; and provide a consolidated set of User Requirements within the sector.

2.1. DEFINITIONS

Concepts and terms used in this document and needing a definition are included in the following table:

Table 2-1 - Definitions

Concept / Term	Definition
Geospatial data / geoinformation:	information about where observations are in relation to one another – any data tagged with a geographic reference is (geo)spatial data. Insights obtained from the analysis of spatial data are referred to as 'geoinformation'
Earth Observation (EO):	the gathering of information about the planet's physical, chemical, and biological systems via remote sensing's data and processing of this data
Spatial Finance:	the integration of geospatial data and analysis into financial theory and practice

2.2. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Table 2-2 - Acronyms

Acronym	Definition
AI	Artificial Intelligence
APAC	Asia-Pacific
ALM	Asset Liability Management
CAGR	Compound annual growth rate
CDP	Carbon Disclosure Project
COP	United Nations Climate Change Conference
CSA	Canadian Securities Authority

Acronym	Definition
AI	Artificial Intelligence
EARSC	European Association of Remote Sensing Companies
ECB	European Central Bank
EO	Earth Observation
ESA	European Space Agency
ESG	Environment, Social, Governance factors
EU	European Union
EUSPA	European Union Agency of the Space Programme
GFANZ	Global Financial Alliance on Net Zero
GHG	Greenhouse Gas
MMRV	Measuring, monitoring, reporting, and verification process
MRV	Monitoring, reporting, verification
NGO	Non-Government Organisation
NZ	New Zealand
SFC	Securities and Futures Commission
SFDR	Sustainable Finance Disclosure Regulation
SGX	Singapore Exchange
TCFD	Taskforce for Climate-related Financial Disclosures
TNFD	Taskforce on Nature-related Financial Disclosures
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNPRI	United Nations Principles for Responsible Investing
USA	United States of America
WWF	World Wildlife Foundation
XRB	External Reporting Board

3. REFERENCES

3.1. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.x]:

Table 3-1 - Applicable Documents

Ref.	Title	Code	Version	Date
[AD.1]				

3.2. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.x]:

Table 3-2 - Reference Documents

Ref.	Title	Code	Version	Date
[RD.1]	European Investment Bank. (2019). 'The future of the European space sector'			
[RD.2]	London Economics. (2023). 'Spatial data for financial management'			
[RD.3]	World Economic Forum. (2020). 'What is green finance'			
[RD.4]	International Capital Markets Association. (2018). 'Green Bond Principles'			
[RD.5]	Hernandez,V. (2020). 'How Satellite Data Is Helping Hedge Funds Outperform.'			
[RD.6]	UK Centre for Greening Finance. (2021). 'State and Trends of Spatial Finance'			
[RD.7]	ESA Commercialisation Gateway. (2022). 'Space for Green Finance'			
[RD.8]	WWF. (2020). 'Spatial Finance: Challenges and Opportunities in a Changing World'			
[RD.9]	Swiss Re Institute. (2021). 'Remote sensing innovation: progressing sustainability goals and expanding insurability'			
[RD.10]	Innovate UK & Satellite Applications Catapult. 'Routes to Market Report 18 - Satellite Technologies for Insurance Services'			
[RD.11]	International Banker. (2020). 'How satellite imagery is helping hedge funds outperform'			
[RD.12]	United Nations Economic Commission for Africa. (2017). 'Geospatial information for sustainable development in Africa - African Action Plan on Global Geospatial Information Management 2016-2030'			
[RD.13]	Matheson. (2021). 'SFDR Factsheet: New ESG Disclosure Requirements'			
[RD.14]	Regulation (EU) 2019/2088: Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector			
[RD.15]	United Nations PRI. (various years). 'Annual report'			

Ref.	Title	Code	Version	Date
[RD.16]	Skidmore, A. K., Coops, N. C., Neinavaz, E., Ali, A., Schaepman, M. E., Paganini, M., ... & Wingate, V. (2021). Priority list of biodiversity metrics to observe from space. Nature Ecology & Evolution, 5 (7), 896-906			
[RD.17]	European Central Bank. (2022). '2022 climate risk stress test'			
[RD.18]	WWF. (2022). 'Geospatial ESG'			
[RD.19]	European Commission. (2019). 'COMMISSION STAFF WORKING DOCUMENT Expression of User Needs for the Copernicus Programme'			
[RD.20]	Taskforce on Scaling Voluntary Carbon Markets. (2021). 'January 2021 report			

4. METHODOLOGY OVERVIEW

This section of the study entails London Economics collecting stakeholder needs and requirements. This began with a desktop review of available documentation and other literature. A workshop followed to compare the results of the review with the views of stakeholders and the state of their business practices. The feedback collected from the workshop will in turn inform further engagement with stakeholders (the already engaged and additional ones) in the form of interviews and potentially an online questionnaire. Finally, a task to translate the collected user requirements from Financial Management jargon to technical EO jargon will be undertaken before dissemination.

4.1. DESKTOP REVIEW

The first stage of this project was an in-depth desktop review of topics identified as relevant. In addition to the reference documents supplied by ESA, London Economics performed a rapid scan of the literature across four key domains: spatial finance, space for climate action, regulations, and already-collected general user requirements of spatial data.

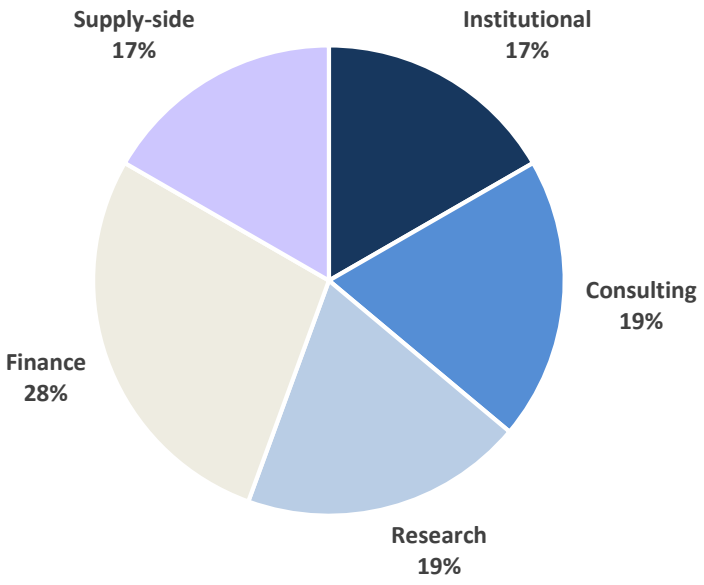
As well as helping to contextualise the emerging market for geoinformation within the Financial Management sector, the desktop review enabled the development of content for the following stages. A long-list of emerging or potential use cases for geoinformation information in each of the four Financial Management domains was formed from this research, including current customers, suppliers, and any identifiable user requirements. A sample of these use cases were presented during the workshop. A database of legislation and regulation formed from multiple sources including the UN Principles for Responsible Investment was used to frame interview questions and provided useful inputs in the prioritisation of consolidated user requirements.

4.2. WORKSHOP

Following the desk-based research, a virtual workshop was held over two days on February 16th (focussing on Investment Management and Green Finance) and February 17th (focussing on Risk Management and Insurance). The workshops were attended by 63 unique individuals representing key organisations in the geoinformation and spatial finance space.

There was a wide geographical distribution of attendees, with 24 different countries represented among workshop signups, of which 13 are ESA Member States or states that fully participate in the programmes of the ESA Education Office. Two-thirds of all participants came from these ESA-aligned states, with most coming from the UK (22%) and Spain (13%).

Figure 4-1 - Sectoral categorisation of event sign-ups



Note: These categorisations were constructed and allocated by London Economics analysts

To preserve anonymity, findings from the workshops are not attributed to specific individuals or organisations. For a more detailed account of the workshop, including attendance statistics and findings, a standalone workshop report (D1.1) is available.

4.3. SEMI-STRUCTURED INTERVIEWS

Following the consolidation and preliminary analysis of the results of the desktop review and the workshop, the team and the engaged stakeholders undertook **one-on-one semi-structured interviews** to elicit more information and further refine user requirements in the sector. Teleconferencing calls were used to discuss specific user challenges and geo-information needs for stakeholder's organisations and projects.

The revised and additional requirements obtained through the interviews were added to the user requirements database generated from the desk-based research and workshops to produce a finalised list of consolidated requirements. This list was shared with a stakeholder board formed of key industry stakeholders to provide final refinements.

4.4. JARGON TRANSLATION (FROM FINANCE TO EO)

Following the information-gathering stages of this work package, the project team had a consolidated list of user requirements, as expressed by the Financial Management sector and associated professionals and their organisations. To ensure that these represent actionable insights for those on the supply-side, the team carefully translated these functional requirements into technical EO requirements, using the language familiar to the EO sector.

This was carried out using a combination of the already-completed desk-based research, dedicated time from an external expert consultant who has experience in both the financial and spatial data sectors, and by working internally with GMV consultants with technical knowledge.

5. SUMMARY OF DESK BASED RESEARCH FINDINGS

London Economics performed a rapid scan of the literature across four key domains: spatial finance, space for climate action, regulations, and already-collected general user requirements of spatial data.

The goals of this desktop review were two-fold. First, a key aim was to understand the current state of existing descriptions of geoinformation requirements for the Financial Management domains studied. To the extent possible, any differences due to geographic regions or seasonality were investigated, along with any requirements generated from issues like health and safety, sustainable development, and any legal or regulatory issues.

Second, the desktop review served as an information gathering process to ensure that well-informed content was presented to stakeholders to ensure they were able to provide feedback that was as effective as possible. Insights on the requirements gathered during the desktop review were leveraged to guide discussions during the workshop and interviews. This section presents the high-level findings from this process.

Further, the expression of user needs that can be found in a 2019 European Commission staff working document proved invaluable in guiding understanding of how user requirements of geoinformation should be gathered, analysed, and presented. To the greatest extent possible, the project consultants have sought to source information that emulates the detail and style of the report's content when consolidating user requirements for EO data within the Financial Management sector.

5.1. GEOSPATIAL IN THE FINANCIAL SECTOR

Geospatial data is an increasingly popular data type that combines information about the position, attributes, and behaviours of objects. By some estimates up to 80% of all information exchanged today has a spatial component – 'everything happens somewhere'.[1] With technological advances, many devices now generate location information at scale, for example satellites or mobile phones. Combined with recent advances in data processing, such as digitalization of many systems, increases in computing power and availability of cloud-computing and machine learning and Artificial Intelligence (AI) methods, large amounts of these data can now be analysed with ease.

Geospatial data can often provide the micro foundations for solutions to important policy and business issues by elucidating human, market, and even economy-level behaviours. For example, during times of crisis like the pandemic mobile phone location patterns were invaluable to policymakers as they could be used to analyse the spread of Covid-19 and define counter measures.[2] Another example is the use of location data to analyse human movement patterns over time and use this to optimise existing systems such as rerouting a transport network in Cote d'Ivoire.[3]

These advances in the collection, computer processing, and analytics support services have democratized the use of geospatial data. EO is an important segment of geospatial data and, with the free and open policy of Copernicus data and services, and increasingly proliferated source of geospatial information.

Data generated from EO processes, and the derived services already support many different economic activities, and the use of EO data is forecasted to expand across markets and geographies. The value of the global civil EO services market now stands at EUR 2.8bn according to the European Union Agency for the Space Programme (EUSPA).[4] The value of EO services is forecast to nearly double to EUR 5.5 bn within the next decade, though other forecasts put these numbers even higher.[5]

The availability of a growing number of satellites gathering EO data flying more diverse instruments allows for innovative solutions to be delivered, tackling an increasing breadth of markets and customers. This development is further supported by better data processing facilities and providers of analytics services (e.g. from Amazon AWS). To put this growth in satellite numbers in perspective, in

[1] Garson, G. & Biggs, R. (1992) 'Analytic Mapping and Geographic Databases'

[2] Grantz, K., et al. (2020) 'The use of mobile phone data to inform analysis of COVID-19 pandemic epidemiology'

[3] Pinelli, F., et al. (2016) 'Data-Driven Transit Network Design From Mobile Phone Trajectories'

[4] EUSPA. (2022) 'EUSPA EO and GNSS Market Report'

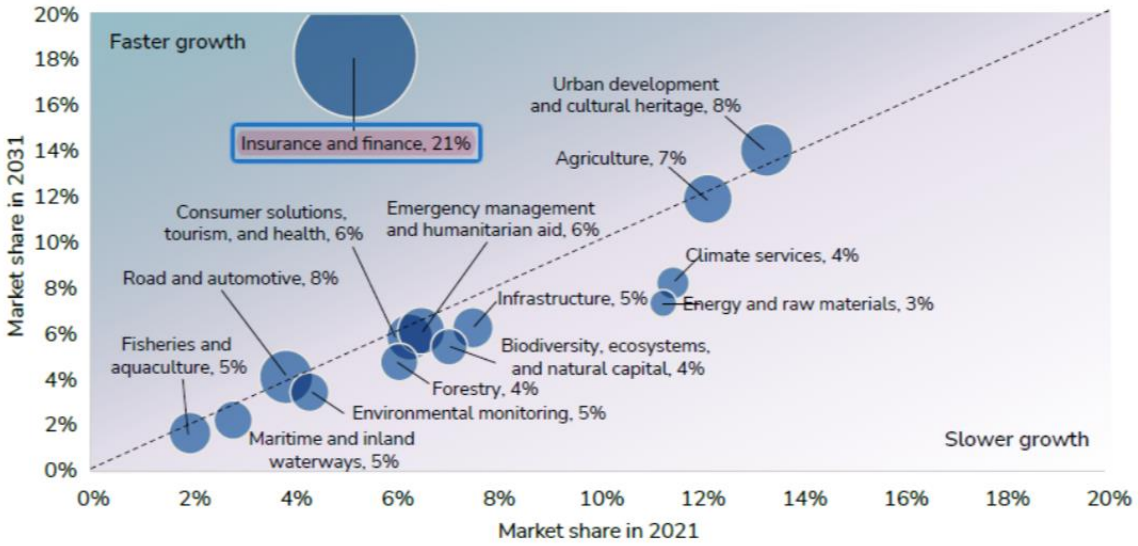
[5] Euroconsult. (2019) 'Satellite-Based Earth Observation Market Prospects to 2028'

June 2023 there were 1,179 EO satellites according to the Union of Concerned Scientists (UCS), which is 22% of all satellites.[6]

While the defence and government sectors have traditionally driven demand for EO services in its early stages, EO data services have a very broad user base today and features in value generating processes across nearly all sectors of the economy. In the civil economy, the five most important purchasers of EO services today are found in the urban development and cultural heritage, agriculture, climate services, energy and raw materials, and infrastructure fields. By comparison, demand for insurance and finance for EO services is relatively small, ranking 11th of 14 segments. EUSPA estimates that the finance and insurance segment purchases EO services valued at EUR 145 min 2021, rising to EUR 1 bn by 2031. Alternative estimates put this value at more than double. For this reason, the EO insurance and finance market is expected to increase in relative importance as its forecasted compound annual growth rate (CAGR) of 20% over the next ten years exceeds all other segments of the market.

The forecasted growth rate of EO services in the insurance and finance sector suggest there is a latent demand ready to be captured. Why this has not already been realised could have many explanations, including that the sector finds little utility in EO data.

Figure 5-1 - EO segment market shares over the next decade



Source: EUSPA. (2022). 'EO and GNSS Market Report'

Note: The size of the bubbles represent the CAGR of each segment between 2021 and 2031

However, surveys about the sector's data use and data needs tell a different story. In fact, many executives in the financial sector are keen to explore alternative data sources, generally. In a 2017 survey, Greenwich Associates found that 80% of investors wanted access to alternative data sources[7] in their search for alpha[8]. The World Economic Forum also found that satellite imagery was the least used data type among alternative data, based on a survey of the financial sector. The authors suggest cost, a lack of skill, and limited use cases are driving the lower adoption rates.

5.2. THE SPATIAL FINANCE PARADIGM

Over the past few years, as geospatial data has become widely available and some financial institutions are beginning to utilize this new source of data, the concept of 'spatial finance' has

[6] Union of Concerned Scientists. (2022) 'UCS satellite database'

[7] Cambridge Centre for Alternative Finance. (2020) 'Transforming Paradigms – A Global AI in Financial Services Survey'

[8] Alpha refers to a measure in the finance sector of performance, indicating when a strategy, trader, or portfolio manager has managed to beat the market return or other benchmark over some period. It is often considered the active return on an investment.

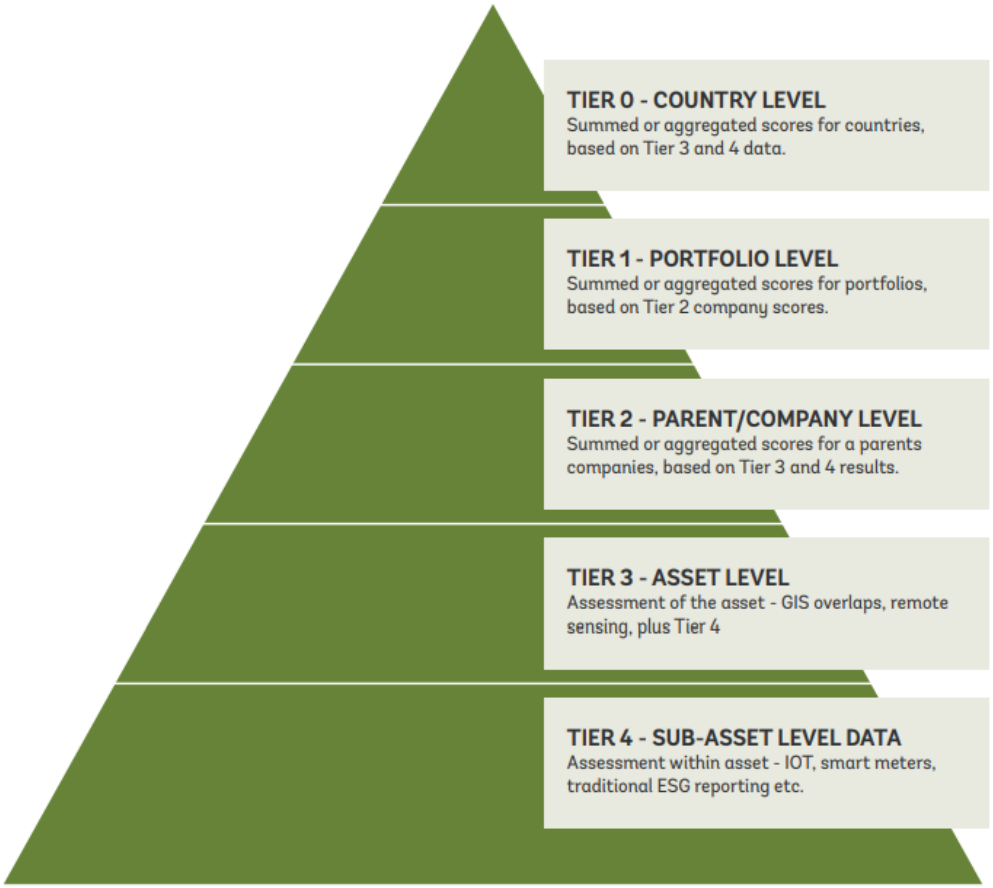
emerged. Spatial finance is the integration and analysis of geoinformation by financial theory and practice.[9] This is also what forms a core part of this project's overall goals.

The **UK Centre for Greening Finance's** 2021 report on emerging developments within the space, including emerging and mature applications, provided a useful starting point in understanding the 'art of the possible' enriching financial with spatial data. In particular, further analysis of the use cases presented allowed for inference of high-level user requirements in different domains in terms of spatial and temporal resolution as well as information integration with other data sources.

Another valuable source of information on the uses and challenges for geoinformation within the Financial Management sector was the recent **ESA** 'Space for Green Finance' study.[10] This study noted that the three key challenges that spatial finance can provide solutions to are 1) data collection, 2) monitoring, and 3) verification. Each of these use-case areas are currently 'dominated' by 'indirect measurements and estimations'.[11]

A comprehensive overview of the spatial finance market is rounded off by the **WWF's** 2020 report on spatial finance.[12] One important discussion point concerns the segmentation of different types of geoinformation in terms of the granularity of their focus, which are arranged into tiers as shown in 0. This provides important definitions and language with which to discuss the performance of different sources of geoinformation and what is demanded by the Financial Management sector.

Figure 5-2 - Geoinformation tier taxonomy



[9] UK Centre for Greening Finance. (2021). 'State and Trends of Spatial Finance'

[10] ESA Commercialisation Gateway. (2022). 'Space for Green Finance'

[11] The report also noted the opportunity size: the estimated current size of the global impact investing market stands at US$715 billion.

[12] WWF. (2020). 'Spatial Finance: Challenges and Opportunities in a Changing World'

Source: WWF. (2020). 'Spatial Finance: Challenges and Opportunities in a Changing World'

The same **WWF** report identifies a six 'major gaps to be resolved', highlighting core areas of emerging demand as the spatial finance sector develops. These major gaps are:

1. A lack of asset data, openly or commercially available, to enable spatial finance assessment of assets, companies, and portfolios.
2. Lack of robust climate and environmental data to use as observational datasets within spatial finance
    a. Issues with format, frequency, relevance, accuracy, comparability, topic coverage, accessibility, saturation
3. Difficulty in accurately assigning subsidiaries to parent companies, and consistently matching parent companies across different systems
4. Complexity around the establishment of benchmarked methods to define climate and environmental impact and risk across different industries
5. Lack of robust supply chain data to use within spatial finance and high data sensitivities around the use of such data.
6. Legal issues and data challenges in the application and use of Tier 4 data in spatial finance in the future

The remainder of this section outlines the user requirements and use cases identified across the financial sector, focusing on insurance, investment management, risk analysis and green finance activities[13], as part of this desk-based review. The desk-based review identified several macro drivers for geospatial data use cases across these financial services activities. The discussion of user requirements and use cases is therefore organized by macro driver. These macro drivers are: 1) demand from un- and underserved markets, 2) the rise of voluntary and mandatory environment, social, and governance (ESG) frameworks and 3) initiatives to green the financial system. Within the sections on each macro driver user requirements and use cases are outlined, with boxes providing more in-depth discussions of specific use cases and highlighting any practitioner examples, where feasible.

5.2.1. DRIVER 1: DEMAND FROM UN(DER)SERVED MARKETS

In many markets demand for new or existing financial products are not met, even though buyers willing to pay for these services exist. Not all demand can be met – sometimes this is simply a case of willingness to pay and cost not intersecting, leaving communities unserved for banking, insurance, or savings products, other times financial institutions lack information to appropriately evaluate and price risks and due to these frictions do not enter some markets.

Utilising technological advances can contribute to opening up many under- and entirely unserved markets, ultimately converting them to profitable markets with millions of customers. One famous example is the African banking revolution. Traditionally, this market was too costly to serve for financial institutions due to a lack of traditional data on, for example credit history, and a need for large branch networks to cover rural areas. A shift in technology with the wide availability of mobile phones could be utilised to provide banking services on mobiles instead.[14] While in 2014, only a quarter of Africans had access to a savings account, by 2018, 43% of those in Sub-Saharan Africa

[13] It is worth noting that the ESA typology of financial management activities, insurance, investment management, risk analysis and green finance, does not always align well with taxonomies used in the financial sector, which often, for example, either speak of the financial sector in general or are very specific, such as 'risk management activities in lending'. This is less of an issue for insurance than for other activities. When discussing user requirements and use cases we follow the naming and descriptors of the respective source. This is to ensure the information provided is accurate but may occasionally cause some confusion vis-a-vis the ESA financial management typology.

[14] Beginning by providing simple banking services such as access to banking and peer-to-peer transactions this has quickly expanded to more sophisticated savings products, such as savings for health care needs.

were financially included. This number is higher still in countries such as Kenya or Uganda, where the growth in mobile banking was particularly strong.[15]

Similar progress may be expected from EO data. For example, a UN report on the promise of geospatial information in targeting and measuring sustainable development efforts in Africa outlines several use cases.[16] However, two barriers hamper many EO use cases actionability. These are ease of integrability with current statistical processes and a lack of a shared, standardised data format. To fully utilise insights geospatial data can provide, statistical and geospatial data agendas need to be better aligned. Defining a formal 'geospatial-statistical framework' could resolve these barriers.

It is also not just the developing world that stands to benefit from EO data. Even in many more developed financial markets, that may be thought of as more saturated, there are users that lack access to specific products or services. For example, small businesses often find it more difficult to access credit regardless of location, in particular in their early stages. Similarly, businesses in rural locations are also often underserved, though to a lesser degree than in emerging markets where branch networks are patchier. Box 1 outlines a use case on how EO data can and is already enabling the expansion of an existing market in very different contexts – lending to farmers. In this market, EO data is extremely useful as it 1) decreases risk by providing more and more granular information on farm productivity leading to improved understanding of their risk and 2) lowers costs of assessing farms, which is traditionally performed in person by branch employees.

Box 1 - Use case examples: expanding lending to farmers

EO data provides many opportunities for the financial sector to expand to unserved and underserved markets. Use cases are beginning to emerge where EO data can lowers costs of assessing clients, increase trust and transparency between the financial sector and its customers, and allow institutions to serve more and more remote clients.

1) Dutch lender **Rabobank** is utilising historical satellite data as an alternative to traditional data to extend loans to 220,000 small-holder farmers in India. Credit markets in emerging markets often lack the information environment of more developed markets where credit scores are widely available. To overcome the lack of comparable information and decrease uncertainty, Rabobank used satellite data to calculate alternative credit score indicators, based on inferred information about past harvests and harvest failures. In addition, Rabobank also provides information gained from their analysis of the satellite data that will help improve the harvest.[17]

2) Elsewhere in India local lender **ICICI Bank**, which already provides loans to farmers, has also started to utilise satellite technology. One problem for banks in many emerging markets in expanding lending are the costs of originating a new loan. Every new loan to a farmer requires the bank to conduct costly checks. An assessor has to travel hundreds of kilometres to assess irrigation systems, crop quality, and land location to forecast farm revenue before credit risk can be calculate and a loan offer made. By instead analysing EO data ICICI can accomplish the same at a fraction of a cost and expand its loan portfolio.

3) In Australia, several large lenders, including the **Commonwealth Bank of Australia, ANZ Bank**, and **Rabobank**, are piloting the use of geo-sensed data to assess farm loans. This is enabled by new data from start-up Digital Agricultural Services (DAS). DAS have mapped every boundary line of every rural property in Australia and combine this data with EO-based data on the type of crop found at the paddock-level. This does not only allow Australian banks to cut costs, as in rural areas farm loan assessments are often conducted in person by branch employees, but also to assess risk with more

[15] World Bank (2018) Digital Access – The Future of Financial Inclusion in Africa. https://documents1.worldbank.org/curated/en/719111532533639732/pdf/128850-WP-AFR-Digital-Access-The-Future-of-Financial-Inclusion-in-Africa-PUBLIC.pdf

[16] United Nations Economic Commission for Africa. (2017). 'Geospatial information for sustainable development in Africa - African Action Plan on Global Geospatial Information Management 2016-2030'

[17] https://www.rabobank.nl/en/about-us/rabofoundation/project/011190869/unique-collaboration-gives-indian-farmers-a-chance-to-grow

certainty – the paddock-level crop information can be used to calculate farm productivity at the crop level.[18]

Consolidated information on user requirements, including those emerging from this use case can be found in Section 8.

Another sector of finance that is bound to capitalise on the EO data opportunity is insurance. Insurance is an industry that is a more mature user of geospatial data generally, as well as EO data. This means that different to the banking sector discussed above, insurers already habitually integrate and work with geospatial data. Therefore, new applications of EO data to insurance may rely more on the availability of better data, either in terms of granularity, quality, frequency or what is being sensed, or the identification of new markets, e.g. new types of insurance users, assets to be insured or insurance products (such as weather indexed or parametric insurance, for example).

A 2021 **Swiss Re** report on remote sensing data's role in insurance serves as a useful primer on data quality required for actionable information in the insurance domain.[19] Of particular interest is the report's discussion of the relative strengths of satellite-provided geoinformation relative to other sources (in an insurance-facing context), this is summarised in Table 5-1 below.

Table 5-1 - Swiss Re's summary of geoinformation data source key features

Data sources	Latency/ revisit time	Geographical coverage	Temporal resolution	Spatial resolution	Availability	Cost	Scalability	Predictive power
Satellites	Near real-time	Global	High	High	High	Chargeable	High	High
River gauges	Real-time	North America and western Europe	High	NA	High	Mostly Free	Low	High
National meteorological sites	Real-time	North America and western Europe	High	High	High	Chargeable	Medium	High
Unmanned aerial vehicles (UAVs)	Not real-time	North America and western Europe	Low	Low	Medium	Chargeable	Low	Medium
Airplanes	Not real-time	North America and western Europe	Medium	High	Medium	Chargeable	Medium	Medium
Mobile and social media data	Near real-time	Fragmented	NA	NA	Medium	Chargeable	Low	Low
IoT sensors in buildings and machines	Real/Near real-time	Fragmented	Medium	NA	Medium	Chargeable	Medium	Medium

Source: Swiss Re Institute. (2021). 'Remote sensing innovation: progressing sustainability goals and expanding insurability'

The same Swiss Re report includes a set of insurance-specific use cases which include detail on benefits and challenges of each use case (included for reference in Appendix 2). Further analysis of these allows for inference of what user requirements are unmet by existing geo-information data. Focusing more on which segment of the insurance value chain could benefit from applying space services, a report from Innovate UK and Satellite Applications Catapult[20] provides a useful value chain overview for property and casualty insurance. The authors consider the sections highlighted in red in

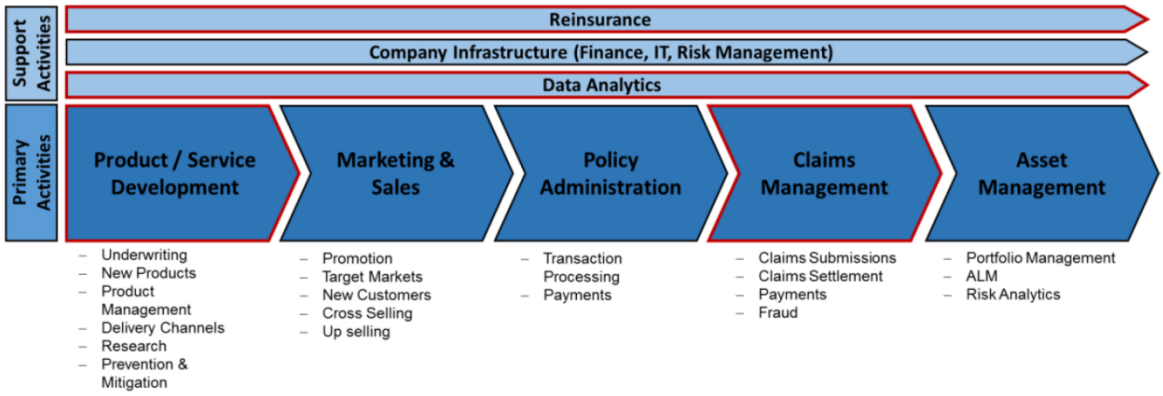
18 https://www.afr.com/companies/financial-services/satellite-data-promises-to-unlock-fresh-capital-for-agriculture-20230403-p5cxjs

19 Swiss Re Institute. (2021). 'Remote sensing innovation: progressing sustainability goals and expanding insurability'

20 Innovate UK & Satellite Applications Catapult. 'Routes to Market Report 18 - Satellite Technologies for Insurance Services'

Figure 5-3 (reinsurance, company infrastructure, data analytics, product/service development, and claims management) as potential avenues for the integration of geospatial information.

Figure 5-3 - Property and casualty insurance value chain



Source: Innovate UK & Satellite Applications Catapult. 'Routes to Market Report 18 - Satellite Technologies for Insurance Services'

Note: ALM stands for 'Asset Liability Management'

The insurance industry is also facing a seismic risk from climate change, with some in the industry comparing the severity of climate risk to mortgage risk during the 2008 financial crisis, resulting in reinsurers in the US already withdrawing from high-risk areas[21]. Essentially, these high-risk areas are turning into un-servable markets, something also familiar elsewhere in the world. For example, in the UK changes in flood risk led to an unprecedented rise in claims from areas historically not at risk.[22] Insurance premiums soon soared to unaffordable levels rendering many properties technically uninsurable leading to the government to step in as, essentially, a reinsurer via the FloodRe scheme.[23] Solving this problem, which may manifest in un- or underinsurance due to availability and affordability issues, provides for many use cases for EO data.

Box 2 - Use case examples: expanding insurance coverage

Climate change is causing large change across all sectors of the economy, including the insurance market. As specialist in pricing risk, insurers are now facing an unprecedented, systematic shift in risk profiles across all geographies and asset classes, affecting insurers and reinsurers alike. Where these changes have led to insurers retreating from markets or the new intensity or frequency of physical hazards prompting new demand for insurance products, a combination of new business models in insurance, such as parametric or weather-indexed insurance, and EO data can often meet user needs.

Under the parametric insurance model actual losses are no longer indemnified. Instead, insurers pay out based on a trigger event occurring or the threshold for a trigger event being exceeded. The trigger event is measured based on an objective index such as wind speeds for cyclone damage or flood extent and depth for a flood. This minimises costs during the pay-out process, which normally requires site visits, and also allows individual pricing based on the level of a hazard realized, something that would have been very difficult to measure and provide at scale previously.

Objectively measuring when this level is reached requires excellent data, at high frequency, at granular resolution, and with high certainty. This is often already fulfilled by satellite data but new types of instruments could enable the extension to further hazards, for example, or higher frequency monitoring of more geographies could also enable the expansion of existing products.

Descartes Insurance developed the first product to insure solar installation owners against damages from hail. This has been possible by using satellite data in two parts of the process. First,

[21] https://www.scientificamerican.com/article/climate-change-is-destabilizing-insurance-industry/#:~:text=Growing%20risks%20from%20climate%20change,financial%20distress%2C"%20Keys%20said

[22] https://www.theguardian.com/money/2008/jun/18/homeinsurance.insurance

23 https://commonslibrary.parliament.uk/affordable-insurance-for-flood-risk-properties-flood-re/

Descartes Labs developed a machine learning approach relying on a combination of EO data and computer vision methods to locate all solar plants worldwide.[24] They then utilised EO data in estimating future hail patterns used to define pay events and pay outs as part of a parametric insurance product.[25]

Consolidated information on user requirements, including those emerging from this use case can be found in Section 8.

5.2.2. DRIVER 2: THE RISE OF ESG

A rise in regulatory initiatives targeting action on climate change, sustainable development, as well as ESG goals has created new data needs for businesses everywhere. The financial sector in particular is singled out by regulators worldwide as a key avenue to realizing a shift to economies that operate in a sustainable manner. As the mediator of large financial flows into all corners of the global economy, the financial sector is a centrepiece to these agendas in two ways.

First, the financial sector is crucial in shifting activity from environmentally unsustainable activities, such as the financing of fossil fuels or companies engaged in deforestation, to sustainable activities, such as companies building infrastructure for new energy systems or companies producing with lower emissions. At the same time, this shift is also crucial to the financial sustainability of the financial sector and individual financial institutions themselves. A bank that retains a large share of its loan portfolio in coal or other activities that rely heavily on the extraction and use of fossil fuels may find these rapidly lose value as regulated prices are introduced for carbon which in turn is threatening their balance sheet. Likewise, a financial system that continues to finance such assets at scale may face stability issues as physical climate risks proliferate increasingly, for example.

As ESG, and in particular environment and climate issues, become more urgent many countries and jurisdictions are introducing or drafting legislation that requires the financial sector to not only disclose data on its own direct operations but to also understand and disclose the impact of their balance sheet, so their loan portfolios or investments. This is a significant step change for an agenda that was previously driven by voluntary disclosure frameworks championed by the third sector.[26] It is in the leading global financial centres and the EU and APAC countries where mandatory climate disclosure is most advanced.

While perhaps not immediately obvious, all these disclosure frameworks are key drivers of demand for geoinformation in the finance sector. Disclosure frameworks require financial sector companies to understand the specific climate, nature, and ESG characteristics of their investee or loan portfolios, which have often not been assessed before and data is not readily available. As many of the disclosure requirements require data to be monitored at the asset and sub-asset level this introduces geolocation data requirements. Some provide strong applications for the space sector, for example the provision of granular physical climate risk data, hazard vulnerability, deforestation, or biodiversity data. As disclosure frameworks are adopted by more companies and across more jurisdictions, these geoinformation needs will only increase over time.

Examples of EO-relevant mandatory disclosures regulations:

- **Article 173 of the French Energy Transition Law**[27]: In 2015 France pioneered mandatory climate risk disclosure requirements by mandating large asset-owners to disclose climate risk and ESG metrics from 2016. These requirements covered 840 insurers[28], mutual funds, pension funds, and provident institutions. Third sector organisations highlighted problems with physical risk

[24] Kruitwagen et al (2020) A global inventory of photovoltaic solar energy generating units. Nature, 598:604-610.

[25] https://descartesunderwriting.com/whitepaper/parametric-hail-insurance-white-paper/

[26] The most relevant, the "group of five", have made important strides towards developing common standards. They are the Carbon Disclosure Project (CDP), the Integrated Reporting Framework, the Climate Disclosure Standards Board, the Global Reporting Initiative, and the Sustainability Accounting Standards Board.

[27] Please find the full legislation text here but note that this specific article has been superseded by European regulation in the meantime: https://www.legifrance.gouv.fr/loda/article_lc/LEGIARTI000031048231

[28] In France, insurers offer life insurance plans that act as a pension savings vehicle. These are the insurers captured under Article 173 of the French Energy Transition Law.

disclosures early on, which many companies did not comply with, likely due to a lack of suitable asset-level data[29].

- **Mandating the Taskforce on Climate-related Financial Disclosures (TCFD)[30]:** Set up by the Financial Stability Board on direction of G20 Finance ministers in 2015, the TCFD initiative aims to allow investors, financial lenders, and insurance underwriters to better price risks relating to climate change by creating greater transparency through a disclosure framework and counts 1,539 financial institutions as supporters.[31] While the TCFD is a voluntary framework, six jurisdictions have mandated TCFD disclosures with four more at the proposal stage[32,] though often this applies to the very largest institutions only33. With these new mandates many more financial sector participants will now need to prepare TCFD reports, and many for the first time. The physical risk assessment portion of the TCFD is an area where EO data and data providers can fill new user needs.
- **Sustainable Finance Disclosure Regulation (SFDR)[34]**: introduced in 2019 the SFDR is an EU regulation that aims to set rules on the disclosures of sustainability risks and impacts relating to financial products offered by participants and advisers in financial markets. These consist of mandatory disclosures on potential adverse impacts on sustainability risks at the entity level.[35]
- **Deforestation commitments:** several new regulations target deforestation by depriving drivers of deforestation of key markets, such as the EU *Regulation on the Export of Commodities associated with deforestation*[36], the US *Forest Act*[37], the UK Environment Act[38] and regional bills in California[39] and New York[40],[41]. For the EU regulation, for example, companies purchasing commodities such as cocoa, cattle, coffee, palm oil, soya, and wood need to prove and disclose that these are deforestation free. Geolocation data can play an important role[42] in showing and verifying deforestation-free origins. Financial institutions may wish to verify their borrower or investee claims using geolocation data.

At the same time, voluntary ESG disclosure initiatives continue to drive data disclosure demands in other jurisdictions. **ESA's** 'Space for Green Finance' study[43] notes that dozens of relevant different

[29] WWF France (2018) "Summary of France's Second Report on French Insurers Climate Reporting Under Article 173 (English Language Summary)".

[30] https://www.fsb-tcfd.org

[31] This number comes from Figure D1 of the 2022 TCFD Status Report: https://assets.bbhub.io/company/sites/60/2022/10/2022-TCFD-Status-Report.pdf

[32] This number comes from Table D, Ibid.

[33]Please see the same table for information on type of financial institutions and thresholds different jurisdictions apply to their mandatory TCFD requirements.

[34] https://ec.europa.eu/finance/docs/level-2-measures/C_2022_1931_1_EN_ACT_part1_v6%20(1).pdf

[35] FDR Factsheet: New ESG Disclosure Requirements: https://www.matheson.com/docs/default-source/sustainable-finance/165_sfdr-factsheet--new-esg-disclosure-requirements.pdf

[36] EU Regulation on the Export of Commodities associated with deforestation [Last accessed 12 June 2023] https://data.consilium.europa.eu/doc/document/PE-82-2022-INIT/en/pdf

[37] US Forrest Act [Last accessed 12 June 2023] https://www.congress.gov/bill/117th-congress/senate-bill/2950

[38] UK Environment Act 2021 [Last accessed 12 June 2023] https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted

[39] AB-416 California Deforestation-Free Procurement Act [Last accessed 12 June 2023] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220AB416

[40] The New York Tropical Deforestation-Free Procurement Act -Senate Bill 4859A [Last accessed 12 June 2023] https://www.nysenate.gov/legislation/bills/2023/S4859

[41] An early initiative is Norway's 2016 ban on public procurement of goods linked to deforestation.

[42] That a commodity is deforestation-free can be proven using various methodologies. While location data is one of these options, none of the regulations are EO explicit. Another way companies can show they adhere to the requirements is by showing all their purchases are certified deforestation-free.

[43] ESA Commercialisation Gateway. (2022). 'Space for Green Finance'

ESG disclosure frameworks exist. Voluntary disclosure frameworks also remain relevant in jurisdictions with mandatory disclosure regimes in place. First, mandatory regimes normally only cover a subset of market participants. Second, the voluntary disclosure frameworks can drive more stringent standards of mandatory disclosure standards by exerting upward pressure. For example, the leading mandatory disclosure frameworks are built on recommendations by the TCFD, a firstly voluntary initiative. And third, voluntary schemes can pilot the disclosure of new categories data, focusing on undisclosed data such as biodiversity or nature more generally – data that are much more difficult to measure, collect and link to individual corporates.

Examples of EO-relevant voluntary disclosure initiatives:

- **United Nations Principles for Responsible Investing (UNPRI)[44]:** signatories of the UNPRI agree to incorporate ESG considerations into their investment analysis and decision-making process, and to actively engage on ESG. As of 2021 the initiative had 3,826 signatories representing $121.3 trillion[45].
- **Taskforce on Nature-related Financial Disclosures (TNFD)[46]:** The task force's aim, analogous to the TCFD, is to set up a disclosure framework for nature-related risks, in light of the lack of information available to financial institutions about their impacts on the natural environment, and how nature relates to long-term financial performance and risk management.[47] This disclosure framework is not yet operational – a final draft version is expected for Q3 2023 with the first companies voluntarily reporting from 2024.[48]
- **The Global Financial Alliance on Net Zero (GFANZ)[49]:** is a group of currently 550 financial institutions[50] that have committed to accelerating the decarbonization of the economy by meeting ambitious net zero targets. This involves developing and sharing best practice methodologies via the initiatives sector specific alliances, among them the Net-Zero Asset Owners Alliance (NZAOA), the Net-Zero Banking Alliance (NZBA), Net Zero Asset Managers Initiative (NZAMI), Net Zero Insurance Alliance (NZIA) and The Venture Climate Alliance (VCA).
- **The Science-based Targets Initiative[51]:** develops frameworks for measuring credible corporate progress against selected climate and nature goals. Corporate goals are certified only where companies can prove they are on a realistic pathway for meeting long-term goals, such as reducing greenhouse gas emissions to zero. 5288 companies (182 financial institutions) have now registered their climate goals, with 2,794 approved[52]. The frameworks for 'Science-based Targets for Nature' are still at the beta launch stage. Currently 17 companies from across the value chain are piloting their use. These new nature targets require significant collection of new location data, such as impact on ecosystems**.**

The data a member of a mandatory or voluntary disclosure initiative has to produce to comply with its requirements is not trivial, rather these initiatives often require data that is not traditionally collected and therefore not straightforward to produce. The Matheson factsheet[53] on the EU Sustainable Finance

[44] www.unpri.org/signatories

[45] For more information, please see the UNPRI website at: https://www.unpri.org/about-the-pri/annual-report-2020/6811.article#:~:text=The%20collective%20AUM%20represented%20by,521%20are%20asset%20owner%20signatories.

[46] www.tnfd.global

[47] https://tnfd.global/wp-content/uploads/2022/03/220321-TNFD-framework-beta-v0.1-FINAL.pdf/

[48] TNFD releases fourth and final beta framework – TNFD. https://tnfd.global/news/tnfd-releases-fourth-final-beta-framework-v0-4/

[49] www.gfanzero.com

[50] https://www.gfanzero.com/about/

[51] www.sciencebasedtargets.org

[52] Figures correct as of 12 June 2023, from: www.sciencebasedtargets.org/target-dashboard

[53] Matheson. (2021). 'SFDR Factsheet: New ESG Disclosure Requirements'

Disclosure Regulation[54] illustrates these nuanced data requirements well. For a broader overview, the **UNPRI** annual reports[55] and their regulation database provide a valuable resource in developing a practical stocktake of existing and upcoming regulations with relevance for geoinformation demand.

The difficulties in collecting geospatial environmental data specifically are outlined in depth in a recent **WWF** report on geospatial ESG[56] which covers strengths and weaknesses of the current data landscape for 'environmental geospatial data'. They diagnose five main weaknesses: 1) temporal inconsistency issues between the multiple data layers often required; 2) Accuracy of open data is often lacking; 3) Spatial resolution of open data is too low; 4) data interdependencies where new products are a combination of including older and flawed data sets and 5) biodiversity is extremely difficult to capture beyond taking spot measures. From these user requirements across a broad range of environmental use cases can be identified.[57]

5.2.3. DRIVER 3: GREENING THE FINANCIAL SYSTEM

The Paris Agreement aims to limit climate change to levels in line with the 1.5-degree target by reducing our reliance on greenhouse gases. To do so, policymakers are increasingly drawing on the financial sector. The financial sector plays a large role in determining the direction and composition of the economy by directing financial flows. Where these financial flows go also determines the stability of the economy overall, demonstrated by the fallout from the 2008 global financial crisis. Climate change is another source of risk that could systematically threaten the long-term stability of the financial system.

To manage the risk climate change poses, central bankers are increasingly seeking to understand the implications of climate change for financial stability. Climate change is now understood to have potentially wide-ranging impacts on economic activities. Sudden pricing changes for fossil fuels present a risk for companies ranging from those holding exploration rights to downstream end users, referred to as 'transition risk'. The physical manifestation of climate change through increases in the frequency and intensity of acute events, such as floods and storms, or the progression of chronic hazards, such as increases in temperature and sea-level rise, pose a risk to many types of economic activity and asset classes. For example, a sea-level rise will lead to a revaluation of low-lying real estate and increases in temperatures, precipitation, and flood pattern changes impact the suitability of land for agricultural use. They are known as 'physical risks'. Box 3 below provides more insight on the state of central bank climate stress test data needs.

Box 3 - Central bank climate stress testing

Central banks have adapted stress-testing methodologies developed after the 2008 global financial crisis to gauge the size of unmitigated climate risks present on the balance sheet of individual institutions and their impact on financial stability. Bottom-up[58] climate stress-test modelling requires data on climate risks at the level of individual assets. So, for example, the climate risk needs to be understood at property level for mortgages or plant level for corporate loans before understanding exposure at portfolio or bank level. EO data can support this process by generating precise and reliable estimates of a range of physical risks. There are already some examples where EO data is used to fill user data gaps:

1) In 2021 the **European Central Bank (ECB)** performed an economy-wide climate stress test exercise, covering climate transition and physical risks. To understand the micro-foundations of physical climate risk across the economy the ECB modelled common risk types for approximately 4

[54] Regulation (EU) 2019/2088: Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector (Text with EEA relevance) https://eur-lex.europa.eu/eli/reg/2019/2088/oj

[55] United Nations PRI. (various years). 'Annual report'

[56] WWF. (2022). 'Geospatial ESG'

[57] The report also includes three detailed case studies of geoinformation's use in emerging applications in Brazil, including the features of the data that are generating value. These case studies are each focused on different scales: the first looks at an asset level example, mining operations; the second a corporate level example looking at soya production (where asset data is unavailable).

[58] Central banks generally use both top down and bottom-up modelling in their climate stress testing exercises.

million European firms using geolocated risk scores provided by climate data provider 427 (now part of Moody's). 427's models draw heavily on EO data to model different physical hazards including floods, sea-level rise, wildfire, water stress, heat stress, and hurricanes and typhoons. Due to shortcomings of data availability at the time, some gaps in the mapping remained, for example flood risk at latitudes above 60 degrees could not be estimated.

2) The **Moroccan Central Bank**, facilitated through a technical assistance project led by the **World Bank**, developed forward-looking physical climate risk assessments to assess impacts on financial and economic stability[59]. Physical climate risks are particularly salient in Morocco, one of the world's most water-stressed countries, where economic modelling suggests that a 25% reduction in water availability would result in a GDP loss of 6.5%[60]. The physical climate risk assessment benefitted from the use of high-resolution satellite data which allows to pinpoint areas particularly at risk with much more precision than other methods and at significantly lower cost.

Consolidated information on user requirements, including those emerging from this use case can be found in Section 8.

How does this translate into user requirements? Some more insights can be gained from the **ECB's** 2022 climate risk stress testing framework[61], which underscores the gaps in climate-relevant data infrastructure that exist within banks. While most banks have a 'medium to long-term' plan to incorporate climate risk into their stress-testing framework, there was near-unanimous agreement that there is a need to either '[improve] data collection from counterparties and/or [engage] with data providers'. This strongly implies that the required data standards for climate stress testing regulations (current or future) can be directly interpreted as a template for user requirements applying to many financial institutions in the medium-term.

Many banks are themselves aware of the shortcomings of their current data foundation, with most actively improving their data collections. The lack of data today, and a lack of coverage from data providers, has led some banks to create shared data collection initiatives. Their goal is to mitigate the lack of company-level data on exposure to transition and physical risks, so they can understand their risks and make more informed choices about their portfolios. The largest of these is the **OS Climate project**[62] headed by Goldman Sachs, BNP Paribas, Allianz, BNY Mellon and Ortec Finance alongside key technology and data partners which aims to create a 'data commons' that is a *"one-stop shop"* for data and analytics tools to enable breakthrough innovations in the area of climate-aligned finance[63]. The open-source data and tools can be integrated into the user institutions respective data architecture via APIs running on Amazon's AWS infrastructure. Projects such as these are driven from within the financial sector show the urgent need for data these institutions have to keep up with regulatory and internal demands.

Other institutions may supplement their own with vendor data. The **UN Environment Programme (UNEP)** recently reviewed the landscape of commercial climate risk providers and found financial institutions face three main challenges when using their outputs: 1) *interpretation of outputs*; 2) *scalability of use* and 3) *model validation*. Other important challenges are *handling big data sets*, *understanding of tools*, *end to end use*, and *stability* (UNEP FI, 2023). These more technical, on the ground issues clearly identify important user requirements relevant to any geospatially based data product targeting the financial sector.

In parallel to climate risk, the interaction between the financial sector and the environment is coming into focus. Like climate change, the continued degradation of the environment at levels that endanger our foundations of life, can be considered a risk to our economies and financial stability. Modelling

[59] https://commercialisation.esa.int/wp-content/uploads/2021/05/Leveraging-Space-Technology-for-Climate-Risk-Finance_Mahul.pdf

[60] https://www.worldbank.org/en/news/press-release/2022/11/03/climate-investments-will-reap-big-dividends-for-morocco-says-world-bank-report

[61] European Central Bank. (2022). '2022 climate risk stress test'

[62] Other similar initiatives exist or are emerging. The Poseidon Principles among ship-financiers and insurers is another example of an industry-led data initiative.

[63] https://os-climate.org/wp-content/uploads/sites/138/2021/11/2021-10-27-Press-release_OS-Climateannouncement_v0.10_draft_clean.pdf?utm_source=LF+Blog&utm_medium=referral

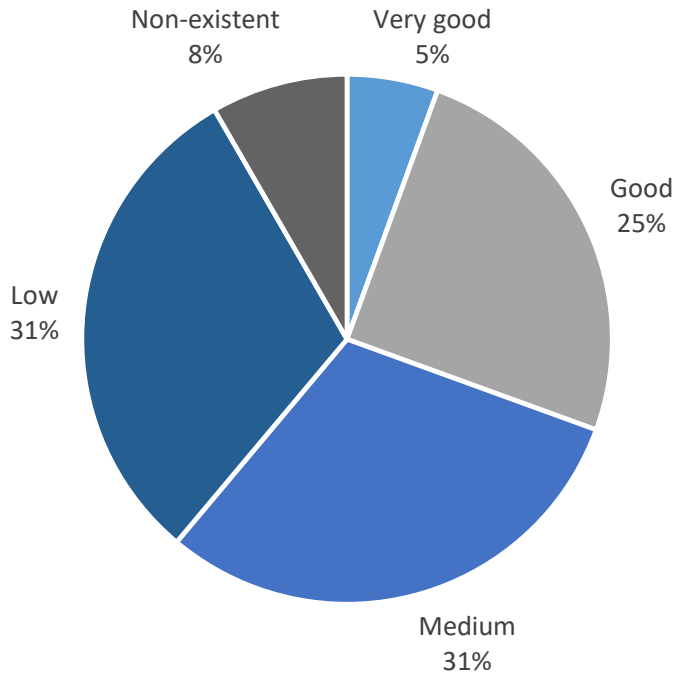
these risks requires large amounts of new data, data that are currently not measured at scale, or measured infrequently, or where measurement is not granular enough, or not measured at all. A 2021 research paper in **Nature**[64] highlights a list of 'biodiversity metrics' that can be observed from space and fill important gaps on nature risk.

[64] Skidmore, A. K., Coops, N. C., Neinavaz, E., Ali, A., Schaepman, M. E., Paganini, M., ... & Wingate, V. (2021). Priority list of biodiversity metrics to observe from space. Nature Ecology & Evolution, 5 (7), 896-906

6. WORKSHOP 1 FINDINGS

In the first part of the workshop on Thursday 16th February we asked attendees to rate their current knowledge of the use of spatial data in Financial Management, and their responses are summarised in the chart below. A majority of the 36 respondents (more than 60%) rated their knowledge as between 'medium' and 'very good'. As the sessions continued, it became evident that the group was relatively well-informed of topics relevant to the workshop and project. The findings from each session are discussed in more detail in the remainder of this chapter.

Figure 6-1 - How would you describe your current knowledge of the use of spatial data in Financial Management?



Note: 36 total responses were recorded.

Key findings from the workshop include:

- Many participants' organisations use (28%) or are considering incorporating (47%) geospatial data into their Financial Management decisions.
- One of the main barriers to using spatial data in finance management sectors is a lack of awareness, understanding, and technical knowledge within this field.
- Regulation and reporting requirements (or lack thereof at present) were also thought to be key blockers of geospatial data use across multiple domains.
- Promising uses of spatial data include monitoring portfolio assets for investment management, identifying physical risk to assets in risk management, and for parametric insurance products in insurance.
- Participants across all domains felt that spatial data had exciting possibilities in the areas of sustainability and climate, including areas such as ESG investing, climate stress testing, and monitoring green finance targets.

6.1. INVESTMENT MANAGEMENT

Throughout the guided discussions in breakout rooms, participants generated a complex and nuanced picture of the demand landscape for geoinformation within the Investment Management sector. To preserve anonymity, quotes and polls are not attributed to specific sources. An overall summary of the discussion points (and their frequency) is provided by a word cloud below.

For the purposes of this study Investment Management services are defined relatively broadly. The industry is highly diversified, with a focus on the allocation of client capital across a wide range of asset classes and investment strategies. This capital is entrusted to investment managers who invest on a client's behalf to deliver a return on their client's capital, mitigate risk, or to deploy that capital in line with particular principles/ethical frameworks. Increasingly common are constraints which take into account ESG considerations, which may be accompanied by associated due diligence and reporting requirements.

While these considerations take different forms across firms and investment strategies, their execution in terms of due diligence and reporting increase the operational cost of investment management. Given these cost drivers, as well as increasing regulatory, political, and social pressure for investment managers to respond to ESG issues such as climate change and ethical supply chains, the adoption of new technology may be of critical interest to this competitive industry. Through enhanced insight, cost savings over other in-situ measurements, or improved timeliness, geoinformation-based insights may enhance an investment manager's product offering.

Figure 6-2 - Word cloud: Investment Management workshop session

Source: EO-FIN Workshop 1 notes.

In Investment Management, geoinformation is already used in the following (non-exhaustive) ways:

- **Analysing market signals** – retail signals can be observed through geoinformation. Sudden changes in stock levels of primary inputs or storage facilities that feed into supply chains can provide immediate information about imminent market changes.
- **Tracking global economic trends –** using historical data, geoinformation can be used to monitor major trends in national and international economic activity, including trade flows, night lights, spectrum density and other proxies for economic activity.
- **Monitoring opaque markets** – geoinformation can be used to bridge gaps in formation and address activity in opaque markets, as well as markets that are difficult to monitor because they are remote/very large.
- **Performing due diligence and monitoring existing assets –** monitoring assets, conducting due diligence for stock selection, ensuring compliance, and assessing risks including ESG.

In discussions throughout the workshop, most participants agreed that the most exciting opportunities for spatial data within Investment Management are within the ESG space, and within this space primarily for environmental factors (rather than social or governance factors). Some participants highlighted more niche applications. For example, a participant highlighted that within the agricultural

sector socio-economic monitoring was an important factor, as geo-spatial data offer particularly interesting opportunities for improvement.

Participants tended to view the integration of geoinformation as an emerging area rather than one where they were already making progress. They felt that geoinformation offered ample opportunity to improve their current processes and approaches. This is reflected in current usage rates of geoinformation in the investment management space: only in 28% of participants represented organisations that *either currently use / have considered integrating / are considering integrating* geoinformation to support their Investment Management activities.

When asked about which geoinformation use case would be most useful to their organisation, an overwhelming majority (74%) of respondents selected 'observing portfolio assets'. Examples of this that participants highlighted as in-demand in the Investment Management sector include credit scoring in the agriculture sector by monitoring the productivity of fields, risk-screening by geo-mapping clients, monitoring carbon-intensity of portfolio assets, evaluating the ESG performance of companies, and the use of geoinformation as proof of due diligence.

The next most popular choices for useful applications of EO data were 'tracking macroeconomic trends' (15%) and 'analysing market signals' (7%). The selection of 'observing portfolio assets' over and above the other two perhaps indicates demand for a more generalised service: the less popular choices represent more highly specified use cases.

One respondent noted that there is a "general lack of understanding in the finance industry regarding spatial data, which is a challenge for Investment Management professionals seeking to integrate new data sources into their decision-making process". On this point, another respondent suggested that data sources are currently presented in an **overly technical** way and would benefit from being explained to Investment Management professionals in simpler terms. Other participants mentioned that whilst there is a growing awareness within the Financial Management sector of the applicability of geoinformation to existing business practices, it is not always used in the right way. Legal issues and reluctance to share relevant data were also mentioned, although one participant noted that for the vast majority of applications, there are "no legal restrictions on using EO data as long as it does not invade someone's privacy directly".

Multiple participants commented on the fact that many organisations ultimately "work with the data that is available" if it provides value, even if it is imperfect. There was also mention of a need for an independent organisation to confirm the **trustworthiness of data**, giving it sufficient power to provide verification and validation. This issue appeared to be a significant blocker to the demand for geoinformation being expressed in the market today. Only 3% of respondents believed that 'most Investment Management firms incorporate geoinformation in their models', with the majority (40% and 33% respectively) believing that either 'some' or 'outlier' Investment Management firms incorporate geoinformation in their modelling.

Another point of discussion was the need for **'data-agnostic' products** which do not require a client-side understanding of the technical aspects of the data underpinning the service. Such a product, it was argued, would mean that financial investors can more easily implement geoinformation into their analyses. There was widespread support for the value of an off-the-shelf product that financial investors can implement into analyses they are already undertaking immediately and easily. The group noted the need for an **intermediate layer of service providers** to process the raw geoinformation into these off-the-shelf products for the Financial Management sector.

When asked what level of granularity is sufficient in the spatial data, participants noted that granularity needs will vary depending on the organisation, and the application of the data, although there was mention of benefitting from improved granularity. One participant noted that the important question is "how the accuracy of EO data can be evaluated in order to make well-informed decisions".

When asked whether assessing investments more frequently is worth paying a premium for, participants noted that this depends on the requirements of the investment, for example, it is not necessary to get very frequent temperature updates when looking at agricultural investments. One participant noted that most cases would benefit from annual reports, but this is highly variable. Another respondent believed that it would be worth paying a premium for, providing the "process is fast and efficient".

There were discussions regarding the trustworthiness of the data and the intentions of corporations. One participant noted that companies may not want their ESG reports evaluated "in a more transparent way", which is a major challenge for the (voluntary) wider adoption of geoinformation within the Financial Management sector.

6.2. GREEN FINANCE

Following the Investment Management session, the Green Finance workshop session allowed attendees to directly focus their attention on how geoinformation can be utilised to improve the use of financial sector products to power the green transition. Their feedback reveals a strong belief in the potential value of such information, but in practice lacks implementation. To preserve anonymity, quotes and polls are not attributed to specific sources. An overall summary of the discussion points (and their frequency) is provided by a word cloud below.

Figure 6-3 - Word cloud: Green Finance workshop session

Source: EO-FIN Workshop 1 notes.

For the purposes of this study **green finance** includes structured financial activities, products, or services, that have been created to mitigate negative impacts that arise from environmental pollution and climate change. These interventions seek to foster the development of greener business practices, operating models, and a sustainable economy as a whole. These efforts can be divided within two broad categories.

The first category are endeavours which seek to augment current investment management processes and asset classes to improve alignment with environmental objectives. This includes screening for ESG issues as described in the preceding section on Financial Management. For example, investment managers may exclude certain assets from their potential investment universe based on concerns regarding greenhouse gas (GHG) emissions, environmental degradation, or biodiversity loss. Alternatively, they may explicitly seek out assets which have **positive environmental externalities**, perhaps through a novel technology or business practice. They may also actively engage with businesses they hold an equity stake in, through mechanisms such as proxy voting. In each of these instances, EO data may offer improved insights, with greater coverage, reduced cost, or improved timeliness to support decision making.

The second category includes those organisations developing novel financial instruments and asset classes to support environmental objectives. It includes an array of debt mechanisms, loans, and investments that are used to encourage the development of green projects or minimize the impact on the climate of more regular projects[65]. One example of this are **green bonds**, which are designated bonds intended to encourage sustainability and support climate-related or other types of special environmental projects. More specifically, green bonds finance projects aimed at energy efficiency, pollution prevention, sustainable agriculture, fishery and forestry, the protection of aquatic and terrestrial ecosystems, clean transportation, clean water, and sustainable water management. They

[65] For more information, see the World Economic Forum: https://www.weforum.org/agenda/2020/11/what-is-green-finance/

also finance the cultivation of environmentally friendly technologies and the mitigation of climate change[66]. Geospatial data and, in particular, EO data, may serve as a critical input in assessing specific environmental and climate risks and thus designating projects for green financing. Furthermore, EO data may also play a central role in the creation of novel financial markets, or in the acceleration of existing ones. For example, the carbon offset markets, where organisations are able to buy and sell carbon credits which correspond to an activity/project that either reduces carbon dioxide emissions or sequesters carbon dioxide, requires a clear mechanism for baseline assessment and subsequent verification. EO enables the possibility to verify the veracity and quality of the generated carbon credits claimed by the activity, bringing objective (quantifiable), traceable, and objective insights into the market that reduces the possibility of *greenwashing*[67].

Geoinformation can be used to aid the proliferation and expansion of Green Finance products by increasing trust of the markets by providing information about the environmental and climate impacts of activities financed under specified green criteria, aiding a verifiable, scalable appraisal of businesses, loans, bonds and projects. This measuring, monitoring, reporting, and verification (MMRV) process supports markets for green products by increasing transparency and thereby the trust of market participants.

The overwhelming majority of participants, 84%, believe that geoinformation can add a lot of value to Green Finance, with only 4% responding that geoinformation can add 'a small amount of value to Green Finance' and a further 8% of responding that this data has 'a very low opportunity to add value to Green Finance'. This is contrasted by only 36% of respondents currently using, having considered or currently considering incorporating geoinformation to support their Green Finance activities. **Sustainable agriculture** and **reforestation** were identified as the key use sectors for geoinformation for Green Finance, particularly for use in crop monitoring in developing nations. The use of geoinformation for **carbon monitoring** and to assess green credentials was also mentioned.

Paralleling the discussion in the Investment Management workshop session, gaining **recognition** of the value of geoinformation was seen as the main barrier to using geoinformation for Green Finance. One respondent noted "a lack of recognition among regulators" (and public bodies more generally) of EO data specifically as high-quality enough information for regulation purposes, often resulting in the same organisations requiring ground-based methods for verification. Even outside of regulation, organisations that set voluntary standards do "not yet recognise EO as a [credible] source" of information on green activities.

Other barriers identified were concerns over greenwashing and the associated negative publicity. The potential to engage in activities that could be labelled as greenwashing prevents some organisations from participating in Green Finance activities, as these are often poorly monitored and verified. The cost of data onboarding (particularly high-resolution geospatial data) for monitoring Green Finance assets hinders organisations further. Another barrier mentioned was that "one set of satellite data is not sufficient and needs to be combined with other sources of data" to extract useful information.

In response to a poll question during the workshop, 54% of participants thought that 'a lack of technical knowledge or skills' to analyse data was the main barrier to using geospatial data for Green Finance. Further, 27% of participants thought that the main barrier was 'a lack of information about potential applications'. Potential solutions, discussed at length by attendees, largely focused on so-called off-the-shelf 'data-agnostic' solutions that provide useful insights to clients without requiring specific investment in skills or infrastructure – the insights do not require a deep understanding of the data that drives them, hence the label of 'data-agnostic'. 8% of respondents thought that the main barrier was the high cost of obtaining data.

Introducing **regulation** and more regular **reporting** requirements to ensure projects are continuously meeting their targets or financing conditions was mentioned as a key area of future interest for using geoinformation within the Green Finance domain, with one respondent mentioning that improved monitoring of outcomes would "increase issuances [of Green Finance financial instruments] from

[66] For more information please see https://www.investopedia.com/terms/g/green-bond.asp and the International Capital Markets Association's "Green Bond Principles," Available at: https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Green-Bonds-Principles-June-2018-270520.pdf

[67] Misleading or deceptive publicity disseminated by an organisation so as to present an environmentally responsible public image

organisations". More generally, one respondent mentioned that there is "still a lot to be done for [geoinformation] in Green Finance to be recognised as a trusted source" of information.

The key blockers emerging from this workshop session are a lack of technical skill to allow organisations to analyse data, and needing data from multiple satellites to have sufficient information for success in Green Finance. However, the respondents also suggested that EO and geoinformation more generally will be important parts of the solution, with one respondent stating that "Green Finance cannot progress without EO."

6.3. RISK ANALYSIS

The risk management session allowed participants to assess the current uses and the potential applications of geoinformation in risk-management processes within the financial sector. The discussions revealed a strong understanding and enthusiasm for the positive impacts of the applications of geoinformation for risk analysis. There was, however, a strong focus on the current constraints of using geoinformation for such processes, such as a reliance on ground-truth data which is highly prone to human error, and consumers in the finance industry lacking the in-house expert teams to analyse and use geoinformation in its raw form, such as satellite-derived EO data.

To preserve anonymity, quotes and polls are not attributed to specific sources. An overall summary of the discussion points (and their frequency) is provided by a word cloud below.

Figure 6-4 - Word cloud: Risk Analysis workshop session

Source: EO-FIN Workshop 1 notes.

For the purposes of this study Risk Analysis includes the process of identifying, assessing, and managing **financial**, **legal**, **strategic** and **security risks** to an organisation's capital, operations, and earnings. Financial institutions typically have a Risk Management function to ensure they identify risks to their operations and manage these risks, in order to mitigate exposure and impact. These functions typically focus on *material risks*. **Material risks** are risks which have the potential to significantly impact the institution financially

For financial institutions the quantity and quality of data is crucial in all stages of the risk process – from identification over assessment, to quantification. Better data can change whether a risk can be assessed at all, the level of granularity at which it can be assessed (for example property rather than postcode level), the precision with which it can be assessed, and the timeliness of information can also change the quantified risk. Given the advantages of geoinformation in terms of frequency, granularity, and unique insight over traditional data, it provides great promise in the area of risk management.

Geoinformation can be utilized within Risk Analysis in the following ways:

- **Quantifying physical risk** – Assessing the materiality of physical risks and quantifying the size of the unmanaged risk.
- **Climate stress testing** – i.e. the assessment of how climate-related risks impact a FI's business across all sectors and geographical locations under stress scenarios. This is now a required exercise for many UK and European banks. Geoinformation can reduce the cost of data collection and improve consistency across financial institutions and over time (see Box 3 - where the stress tests are described).
- **Forecasting to manage volatility** - Advance warnings of supply chain developments or disruptions, provided by geoinformation, can be crucial to forecast and mitigate against the worst impacts of volatility.
- **Measuring socio-economic risk** - Emerging applications of high-resolution geoinformation enables tracking socio-economic trends and human-level events such as political unrest or terrorism events with implications for understanding risks to business continuity and regional risk levels.

Multiple participants in the Risk Analysis workshop session noted that the bulk of insurance sold is against material risk, and so this is the most likely source of demand for future and emerging products. This is supported by the poll result where 75% of respondents believed that using satellite-based EO data to identify physical risks was the option which could generate the most value in the long-term for Risk Management professionals. It may well be the case that stakeholders have a mistaken understanding of the scope of climate stress testing: one participant stated that they did not "see a difference between physical risk measuring and climate stress testing". Despite this assertion, climate stress testing prescribes very specific scenario analysis and quantitative modelling exercises focused on already-owned portfolio assets, with the specifics defined by the relevant regulators. Measuring physical risk is far broader (without prescribed methodologies or modelling approaches), may not be strictly climate-focused, and can be performed before assets are acquired. This example highlights the importance of **stakeholder education** as part of the process to understand demand for geoinformation-based products and services in the Financial Management sector.

Another option in the same poll, 'managing volatility', was found to be "of less concern" for respondents. This use case for geoinformation was felt to represent a "smaller potential market", and hence less demand existed for such services. Despite the strong focus on the identification of physical risks to assets, attendees did raise **biodiversity** and **nature risk** as other potential sources of demand. This may be explained by the increased attention on this area in the policy space. For example, the United Nations Climate Change Conference (COP) for biodiversity just finished in December 2022 and the TNFD is also ramping up. 25% of respondents believed climate stress testing was the most important and none of the respondents polled believed that 'socio-economic risk management' had the potential to generate the most value in managing long term risks. This stance was underscored in the breakout session, where one participant stated that "Socio-economic risk measurement is also of low priority, and it will [only] become relevant [once it impacts assets] on a macroeconomic level".

Participants highlighted that in some regions or situations, there is a growing need to update risk models to take account of more dynamic variables. For example, human-driven geographical change includes both climate change (rising sea levels, warming climate) and urbanisation in the developing world. Each of these changes the risk profile of entire areas over time, and in some areas such as the developing world participants felt that this is of particular interest – "very applicable to exploding urbanization in the developing world". The relevant data could be difficult to obtain from the ground because the data is changing rapidly, or it is impossible to travel to a specific location (e.g., due to political instability, conflict, or remoteness). Satellite-based EO data was specifically identified as a technology that can offer an efficient and accurate way to capture this geoinformation.

It was further pointed out that there are only a few global projects that allow you to assess the **vulnerability** of asset-specific risks (e.g., floods) and hence damage curves at a portfolio level, despite the "obvious value" this generates for Risk Management professionals. This was supported in the polls where only 20% of respondents stated that they were aware of their organisation incorporating geoinformation in their Risk Analysis processes.

Awareness and understanding of what is possible with geospatial information are key blockers. Some attendees had organisational experience in training institutions to assess portfolio risk and noted that doing this on a global scale generally requires in situ assessments and ground-truths which

themselves are "highly" prone to human input errors. One participant stated that this makes assessing the vulnerability of their assets globally very difficult because of the reliance on hard-to-collect ground-truth data. One participant also noted that consumers in the finance industry often lack the in-house expert teams to analyse and use geoinformation data, including EO data from satellites. This was underscored by another participant in the breakout rooms who opined that "[while] regulators in Europe are very ambitious, the data provision is not ready, nor are the teams in the companies".

Also on the point of awareness and understanding, participants further noted that there is a need to be both aware of the technology and to have information on intermediate companies that can actually provide the analysis - "the middle layer [of companies] able to generate ready-to-use data is not well developed". There was a consensus among participants that there are knowledge gaps regarding geoinformation data handling and analysis. Discussions surrounding the **reduction in the reliance on ground-truth data**, and the development of a "missing market" for such data and its processing were strong indications of potential future demand. This was again supported in the polls where 33% of respondents stated they were not currently using geoinformation but were considering incorporating it in Risk Management processes in the future.

A key distinction was drawn between climate (or 'risk' models) and vulnerability (or 'value at risk' models) that are used within the insurance sector under the name 'CAT modelling'. Participants believed that these two different classes of model are generally not integrated, meaning the Financial Management sector often does not meaningfully integrate climate risk models into their portfolio risk management analyses.

6.4. INSURANCE MANAGEMENT

The insurance session allowed participants to analyse the potential benefits and constraints of using geoinformation for insurance processes. The discussions highlighted some of the potential advantages of using geoinformation, such as expanding market access to those previously uninsured by providing a higher granularity of data than currently exists, which could allow firms to gain a competitive advantage through product innovation based on this improved data. There were extensive discussions regarding the current constraints of using geoinformation for insurance purposes, with the most significant of these being legislative issues making geoinformation unusable on its own in certain contexts.

Figure 6-5 - Word cloud: Insurance Management workshop session

Source: EO-FIN Workshop 1 notes.

For the purposes of this study the **Insurance Management industry** is defined as the section of the finance industry that provides risk management solutions in the form of insurance contracts. Insurance contracts serve as a hedge against uncertain or contingent losses to assets or occurrences which may impact business operations. The contract, or insurance policy, details the conditions and circumstances under which the insurer will compensate the policyholder, or their designated beneficiary. The core business functions within the insurance management industry pertain to investment management, actuarial services, underwriting, and claims[68].

Geoinformation can add value across the full range of insurance industry activities. For example, geoinformation can be used in the following ways:

- **Validating self-reports** - Insured assets can often be observed through satellite-based EO-provided geoinformation. Self-reported asset inventories and states can then be validated against remotely captured data on the asset's condition.
- **Assess claims against policies** – pre- and post-claim geoinformation can be used to rapidly assess the extent of insurance pay-out required, enabling a faster, more accurate, and less costly claims process.
- **Parametric insurance products** - Insurance policies that automatically pay out based on measurable events (e.g. storms, earthquakes, crop damage) can be directly supported by geoinformation, and are particularly advantageous in cases where other data is often poor or unavailable, such as rural or less developed (or both) regions.
- **Expanding coverage** - The ability to remotely monitor assets, and hence add value through validation, assessing, and creating new financial products can mean satellite-provided EO geoinformation allows expansion of coverage to areas previously deemed too remote or unprofitable.

In terms of the demand for geoinformation-based services, all of the use cases mentioned (validating self-reports, assessing claims against policies, parametric insurance products and expanding coverage) were deemed to be valuable in the discussions with workshop participants. One participant stated that for them, "all [of the use cases] and more" would make a big difference for their organisation because of the link between improved information and the pricing of risk by insurers: "the better the data, the more accurate the pricing". When prompted to select the most useful use case for their organisation the majority (71% of respondents) believed that **parametric insurance products** would be the most useful. The remainder, 29% of respondents, believed that assessing claims against policies represented the best use case for their organisation.

The participants identified several barriers in the discussions. **Regulatory issues** arising from using EO data for insurance purposes were mentioned, with one participant highlighting that "in the US" it is currently against federal regulation "to incorporate satellite EO for the purpose of crop insurance". It was further noted that geospatial solutions do not fit with regulatory requirements more generally and that therefore many companies maintain protocols and data governance rules that prevent their adoption. An additional major blocker identified was the **lack of** provision of **customer-ready products**. One participant noted that geoinformation is often not being utilised due to its relative "complexity", and that "it is not ready-made for end users". This currently leads to a serious inability to integrate geoinformation with the existing systems and processes insurance companies use, despite "corporations [already having] spent a lot of time, money, and effort to try and understand the usability of EO data".

Several areas of potential growth in demand for geoinformation-based products and services were examined by the participants. There was a discussion regarding the potential **use of high-granularity data**. In the UK, insurance modelling is reportedly mainly conducted using postcodes, which can cover areas that are not localised enough for assessing the risk posed by many hazards. Properties that are mislabelled as high-risk for flooding based on postcode data can be relabelled more appropriately using high-granularity data (e.g., property on a small hill in a floodplain). This use of high granularity data to better classify property risk allowed the expansion of the market to those previously uninsured. Thus, high-granularity data can give add value to insurance companies and society more broadly, if employed correctly.

Participants also identified as an issue the trapping of the geoinformation and EO data ecosystem in "pilot schemes" as an issue. In effect this means that funding is secured to develop prototypes but

[68] Hernandez,V. (2020). 'How Satellite Data Is Helping Hedge Funds Outperform.'

this money runs out before the product or service can be scaled to the point of financial sustainability, meaning the impact of the pilot scheme does not persist long-term. In the UK for example, insurance companies operate quite traditionally and take time to change. Therefore, the time element for small to medium pilots does not suit their cash flow and they end up running out of money in that time. **Moving beyond pilot schemes** for EO data providers was identified as an area of great potential.

7. INTERVIEW FINDINGS

7.1. PARTICIPANTS

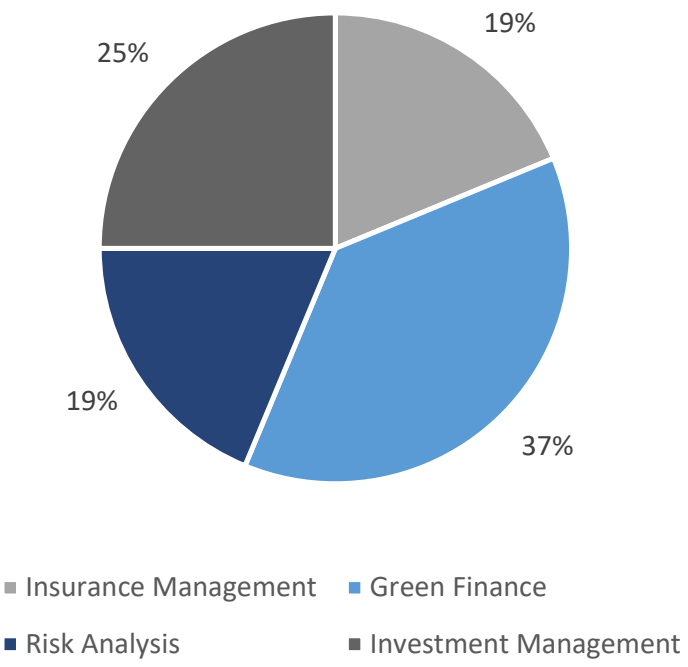
A total of 13 people participated in the interview process over an 8-week period. They were carefully selected to ensure comprehensive geographical and sectoral coverage.

Most interviewees work in an organisation that operates at a global or continental scale (rather than country-specific), with a majority of the continental focus directed towards Europe. Despite this, a meaningful share (77%) also had interests outside of Europe to some extent.

Approximately 40% of participants indicated that their organisation had experience actually working with geo-information, notably lower than the 54% who had some level of personal experience from previous roles.

Considered by market alignment, a majority of the interviewees were aligned to the Green Finance, with the other Financial Management markets (Insurance Management, Risk Management, Investment Management) represented in approximately equal numbers.

Figure 7-1 - Sectoral alignment of interviewees



7.2. CURRENT USE OF GEO-INFORMATION

When asked to rate their own personal and their organisation's experience in using geo-information, interviewees noted that their organisations had more experience than they do personally in Investment Management and Green Finance. The reverse was true in Insurance Management and Risk Analysis, with the latter showing the most marked divergence.

Where geo-information is not currently used in their organisation, interviewees gave reasons ranging from a lack of internal skills, recognition of the benefits by senior figures, and difficulties linking geo-information to other data types.

For those currently utilising geo-information in their organisations, the most common data suppliers were Copernicus, Google, and other commercial suppliers including Planet Labs. There were a range of supplier types included in the responses, including intermediate companies that pre-process data before selling it on to customers.

Among the interviewees, the key perceived drivers of demand for geo-information included the following factors:

- **Economics** – lower costs and improved scalability of information-driven services
- **Objectivity** – the impartiality of remotely collected geo-information
- **Big Data** – the opportunities presented by analysis of very large geo-information data sets
- **Improved quality of analysis** – integration with other data types to improve models

7.3. VIEWS ON GEO-INFORMATION CAPABILITIES AND DEMAND-DRIVERS

Interviewees perceived a number of barriers to the wider use of geo-information within the Financial Management sector. Chief among these are the **start-up costs** of training staff, purchasing or collecting the geo-information data itself, and developing new methodologies to utilise the data. They also highlighted a **lack of uniformity in terms of the product offering** of data suppliers (e.g. asset classifications, degree of pre-processing, language support), and the added complications this brings when attempting to integrate geo-information into business processes. These complications only further increase the perceived start-up costs in the mind of senior staff who allocate budgets.

Acceptance (or lack thereof) **of the value of geo-information**'s integration into existing models and processes was also felt to a significant blocker to further uptake. Interviewees in the private, public, and third sector all mentioned that demonstrating this value without concrete use cases already demonstrated made it all the more difficult to secure resources to build new services on top of geo-information. This may also be attributed to the highly specific use-cases highlighted by interviewees as ongoing projects within their organisations; it is perhaps unsurprising that public examples of sufficiently similar projects are rare.

Perceived major opportunities from further integration of geo-information into Financial Management processes included:

- **Granularity –** higher precision insights into key model parameters
- **Visibility & accountability** – the potential objectivity of data creates opportunities for trust-driven markets to grow and develop in new ways
- **Automation** – a repeatable data generation process creates an opportunity to automate tasks relating to monitoring and forecasting within the financial sector
- **Wider applicability** – interviewees felt it was highly likely that processes developed for one geographic region or market could be readily adapted and deployed in different situations

Beyond those specific opportunities, interviewees related plans to work with geo-information in a number of ways. These included the **integration of such data with more data types and layers**, the explicit linking of project financing to geo-information derived monitoring processes, and monitoring sites for greenhouse gas emissions.

Regulation was, somewhat surprisingly, not an area that interviewees were particularly well-versed in. While it has the potential to be a significant driver or challenge for the wider use of geo-information, most interviewees did not name specific relevant regulations or consider them relevant other than in potentially driving demand in the future. Where regulation was covered in more detail, the **European Taxonomy** was most often referred to. On the negative side, organisation-level regulations among carbon credit verification standards boards over the use of geo-information were felt to be unfairly restrictive, meaning geo-information had a limited role to play under the current rules. Another regulatory issue highlighted was the involvement of foreign actors (data providers or processors) in domestic financial markets such as insurance – in some cases this proved to be a blocker.

When considering the capabilities of the workforce within their organisation, interviewees had a wide range of responses. Skills and funding for training were generally felt to be inadequate, and organisations that had sufficient technical capacity acknowledged that this was a rarity. Both **in-house skills** and the necessary technical abilities of clients for developed products and services that utilise geo-information were flagged as challenges.

With regards to external service providers of geo-information and analysis based upon it, interviewees remarked that while there are certainly market players, the **sensitivity** of projects and **lack of off-the-shelf tailoring of services** available meant that often this layer of companies was lacking. This

only further highlighted the need for internal capacity to build highly tailored tools based on geo-information.

7.4. AWARENESS OF GEO-INFORMATION CAPABILITIES

Turning to the interviewees understanding of the capabilities of geo-information and services built on top of this data, it appears that a majority believe their technical requirements are met through currently available geospatial capabilities. In some cases the only hurdle remaining is not technical and is only convincing senior stakeholders of the return on investment. In other cases products and services are still under development despite being technically feasible. However, a significant proportion of interviewees (38%) were unsure about the fit between geo-information capabilities and their specific requirements.

When asked whether they thought that sufficient awareness exists around the uses of geoinformation in the Financial Management sector, interviewees were largely pessimistic. While pockets of good awareness exist, primarily in the insurance and green finance markets, the overall story was one of awareness being limited by demonstrated use cases.

7.5. TECHNICAL REQUIREMENTS

Parameters that interviewees were interested in measuring included:

- Water extent
- Foliage cover
- Crop area coverage, yields, and damage for insurance products
- Greenhouse gas emissions
- Biodiversity
- Land use categorisation
- Telecommunications connectivity
- Precise locations of assets
- Water cleanliness

To the extent that they represented concrete user needs, these will each be considered in greater detail in Section 8.

7.6. FUTURE OUTLOOK

When asked to consider how they see things changing in the future, interviewees noted a range of areas they expect to see develop. Efforts to develop in-house capabilities are already underway in some organisations, and these are expected to generate benefits by then. In conjunction with this, the rise of **AI-based techniques** to automatically integrate geo-information into business processes was mentioned by multiple interviewees as a likely outcome.

Increasing regulatory pressure to collect and publicly report data on a range of business activities was believed to be a probable driver of far richer datasets in the future, providing greater opportunities for the combination of geo-information with other data types.

Finally, the acceptance of geo-information as a source of objective information and ultimately **validation** of other data sources was believed by many to be a likely development.

8. CONSOLIDATED USER REQUIREMENTS

8.1. INTRODUCTION AND APPROACH

A main objective of this project is to determine the requirements of users within the Financial Management sector in the near future and the present, as well as capabilities of the Earth Observation sector to service these needs.

This section presents a summary of the challenges identified, referred to as 'user needs,' from the perspective of the business process in the Financial Management sector. This complements and consolidates the information and insights discussed earlier in the report. It is important to note that not all needs are directly linked to EO capabilities.

The identified needs were further matched to key geo-information requirements. This was achieved through the project team's expertise in the Financial Management sector. These key requirements, also available in a database format, will be utilised in a gap analysis (WP3) and in the extraction of insights to support the prototype design in WP4.

The database structure design includes **four blocks of information:**

Block 1- Preliminary information of the needs/requirements:

a. [ID], [User's Expression]; [Definition Level]

Users' expressions were classified into the following Definition Levels:

i. Generic Need
ii. Observation Need
iii. Specific Product
iv. Technical Requirement

Where:

- **Generic Need**

  This category does not refer to any specific observation need, nor to any product requirement, but to the service boundary conditions that make it possible for the user to utilize a geo-information product or optimize the use of it (e.g. a method of accessing the data).

  Additionally, if the user is not able to express the requirement as an Observation need or a Specific Product or a Technical Requirement, then his/her need will be a 'Generic Need'.

Generic Needs help us understand the protocols underneath the business processes, that is: the stakeholders' 'jobs'.

- **Observation Need**

  A relatively general requirement expressed by the user with little specification, using non-technical terms and without requesting any specific product. It could also be a desired outcome (e.g. "Better crop production monitoring").

Observation Needs help us understand the need for geospatial data from the personal perspective of stakeholders

- **Specific Product**

  This field is to indicate the requirement of a new product, e.g. "Annual cocoa tree plantation estimates", which has been specifically identified – as opposed to the broader needs expressed as Observation Needs. Despite this higher level of precision, no technical info is provided.

Specific Products helps us understand the need for specific geospatial products and services.

- **Technical requirement**

  This field is to indicate requirements expressed with specific figures referring to technical aspects (e.g. spatial or temporal resolution). In contrast with previous examples, this field could be "1-m resolution layer with annual olive trees counts within land parcels". Note the difference with

the example above where no technical specification is provided by the user. This information will go in Block 3 (below).

Technical Requirements help us understand whether satellite-based EO is a solution for the "pains" of a given stakeholder, or not, in which case there is gap between requirement and capability.

Block 2 - Traceability and Characterisation:

a. [Source Type]; e.g. Document / Interview / Questionnaire / Other

b. [Source Name]; [Source Date];

c. [User Domain]; e.g. Investment Management; [User Subdomain]: e.g. Night lights monitoring.

Block 3 - Technical requirements:

a. [Area to monitor]; e.g. horizontal and/or vertical coverage

b. [Spatial Resolution]; e.g. horizontal and/or vertical unit of observation

c. [Temporal Coverage and Resolution]; e.g. update frequency, archive length, forecasting length

d. [Data throughput]; e.g. tasking time; dissemination time; data format

Block 4 - Gap Analysis

a. [Current EO Solutions]; *to be completed as part of WP2*

b. [EO Solutions available in next 5 years]; *to be completed as part of WP2*

c. [Identified Gaps]; *to be completed as part of WP2*

Blocks 3 and 4 will be updated and populated as WP1 and WP2 progress; meaning that the database will be kept alive during the duration of the project.

The data gathered was analysed and the main findings are described in the Section 8.2.

8.2. FINANCIAL MANAGEMENT MARKETS AND USER NEEDS

This section gives an overview of the challenges and hence needs of users within each of the four identified Financial Management domains. For these users' expressions (including those where only a general need was expressed), the Team, where possible, has identified a geo-information (or Earth Observation) requirement. The fulfilment of this requirement would go some way to resolving the challenge that a user experiences. It is often the case that a need can be addressed by more than one geo-information requirement, and so the requirements are referred to with a numerical identifier that is expanded upon in Section 8.3.

For those observation needs where the users have not identified any technical requirement (see Block 3 of the database above), the project team have inferred the values that they judge sufficient to enable covering the need. For example, if a user said "I need seasonal monitoring of critical infrastructures", the team may add: Very High Resolution (0.5 m or higher) optical and SAR data (for subsidence analyses, for example).

The following subsections present a summary of the users' expressions of needs in each FM sector classified as Generic Needs (not leading to any observation/geoinformation need) and Observation Needs. For the latter, user needs have been further segmented into Subdomains. The need, general requirement, or technical requirement has been written in blue. Section 8.3 will summarise Block 3 – Technical Requirements for the needs that had stated or support inferred specific values for the technical requirements parameters.

8.2.1.INVESTMENT MANAGEMENT

a) Generic Needs

[UN1] Lower cost of integration of geo-information into existing systems and data processes

Investment managers need to carefully consider the cost of integrating new systems and data processes when implementing new technologies or tools. This factor is relevant as it directly impacts the overall cost structure and efficiency of their operations. Evaluating the integration costs helps investment managers make informed decisions about adopting new technologies while considering the potential benefits they bring.

[UN2] Easy-to-access complementary data layers

Having access to complementary data layers is valuable for investment managers. Additional data layers, such as demographic information, market trends, or regulatory data, can enhance their decision-making processes and provide deeper insights into investment opportunities or risks.

[UN3] Independent validation of data accuracy

Investment managers rely on accurate and reliable data for their investment analyses. Independent validation of data accuracy helps ensure the quality and integrity of the data used in their decision-making processes, reducing the risk of making investment decisions based on incorrect or misleading information. This validation is generally understood to be costly to undertake.

[UN4] Less limited data disclosure from operators and owners

The more information available to Investment managers, the better decisions they can make in pursuing their investment mandates. The current owners and/or operators of assets of interest can stymy due diligence by failing or refusing to share key data, which is of particular importance when seeking to combine data with geo-information.

[UN5] Skills to integrate/reconcile geo-information with existing systems and data processes

Investment managers need the necessary skills and capabilities to integrate and reconcile geo-information with their existing systems and data processes. This enables them to effectively incorporate geospatial data into their decision-making processes, ensuring seamless integration and accurate analysis.

[UN6] Standardised annual or quarterly reporting

Standardized reporting is crucial for investment managers to communicate investment performance and compliance with regulations and any other mandates (e.g. ESG or environmental commitments) to their stakeholders. Annual or quarterly reports provide transparency and consistency in reporting investment results, facilitating comparison and evaluation of investment strategies. The significant resource cost incurred in producing these reports makes it a key challenge face.

[UN7] Standardised data

Having a widely-used and agreed-upon asset taxonomy or typology is beneficial for Investment Managers as it enables consistent categorization and comparison of investments across different portfolios and investment strategies

[UN8] Due diligence process support

Geo-information can serve as evidence of due diligence for investment managers. By utilizing geospatial data and analysis, they can demonstrate that they have considered relevant factors, such as environmental or regulatory considerations (e.e. Sustainability), when making investment decisions. This helps provide transparency and accountability in their investment processes.

b) Observation Needs

[UN9] **Subdomain: Stock level and supply chain analyses**

For investment managers, understanding stock levels and monitoring the supply chain is crucial for assessing the performance and potential risks of companies they invest in. This information helps them make informed decisions regarding investments and manage potential supply chain disruptions that could impact the value of their holdings.

[UN10] **Subdomain: Population analyses**

Investment managers need to consider population density (per small geographic units) when making investment decisions. By monitoring population density in small geographic units, they can gain insights into consumer demand, market potential, and growth prospects for specific regions or industries. This information helps them assess the viability and potential profitability of their investments.

Subdomain: Asset surroundings characterisation and mapping

[UN11] A i) realistic assessment of accessibility to the assets and…

[UN12] ii) analysis of potential risks in specific regions is important for investment managers to understand the true characteristics of assets. More specifically, users referred to the collection of information on reach and catchment areas of businesses, positioning of assets near transportation hubs and key infrastructure, and to assess property accessibility and convenience area.

[UN13] **Subdomain: Risk-screening**

Users identified the need for geo-mapping clients. This allows investment managers to assess and manage risks associated with specific geographic areas. By analysing client locations and mapping them against various risk factors such as political stability, economic conditions, or environmental risks, investment managers can identify potential risks and tailor their investment strategies accordingly.

[UN14] **Subdomain: Project screening**

Users identified the need to screen the feasibility of projects, particularly infrastructure projects, against different hazards criteria; for example, extreme weather events; climate change derived hazards (e.g. sea level rises), and natural hazards (exacerbated by climate change, like floods or forest fires). This enables them to propose corrections and modifications in a project design before it is executed; or reject the project when needed.

[UN15] **Subdomain: Carbon-related analyses**

As environmental considerations become increasingly important, investment managers often identify the need to monitor the carbon intensity of their portfolio assets. This involves tracking the carbon emissions and release of other gases associated with the companies or assets they invest in, helping them align their investment strategies with sustainability goals and regulatory requirements.

c) Specific Product

[UN16] **Subdomain: Economic activity and urban development analyses**

As an indicator of economic activity and urban development, nighttime light monitoring provides valuable insights for investment managers. By analysing changes in night-time light intensity, investment managers can gain insights into the growth or decline of specific regions or industries, helping them identify investment opportunities or potential risks.

[UN17] Another key area of economic activity that investment managers have a growing need to understand is the near real-time tracking of marine vessels to understand their routes and fuel usage. These are crucial inputs into estimates of their emissions of GHGs, which professionals identified as increasingly important data.

Subdomain: Crop analyses

[UN18] For investment managers involved **in** agriculture or commodity investments, i) monitoring crop productivity and…

[UN19] ii) identifying the types of crops being grown is essential. This information allows them to assess the performance and potential risks associated with agricultural investments, such as crop yield, market demand, and commodity prices.

Table 8-1 - GEO-INFORMATION NEEDS within the Investment Management sector

Block 1 - Preliminary information of the needs/requirements			**Block 2 - Traceability and Characterisation**
ID	**User's Expression**	**Definition Level**	**User Subdomain**
UN1	Lower cost of integration of geo-information into existing systems and data processes	Generic Need	Cost management
UN2	Easy-to-access complementary data layers	Generic Need	Data integration
UN3	Independent validation for data accuracy	Generic Need	
UN4	Less limited data disclosure from operators and owners	Generic Need	
UN5	Skills to integrate/reconcile geo-information with existing systems and data processes	Generic Need	Skills
UN6	Standardised annual or quarterly reporting	Generic Need	Standardisation
UN7	Standardised data	Generic Need	Standardisation
UN8	Due diligence process support	Generic Need	
UN9	Understanding stock levels and monitoring supply chains	Observation Need	Stock level and supply chain analyses
UN10	Need to understand population density when making investment decisions	Observation Need	Population analyses
UN11	Realistic assessment of accessibility to assets	Observation Need	Asset surroundings characterisation and mapping
UN12	Analysis of potential risks in specific regions	Observation Need	Asset surroundings characterisation and mapping
UN13	Need to geo-map clients	Observation Need	Risk screening
UN14	Need to screen the feasibility of projects against different hazards criteria	Observation Need	Project screening
UN15	Need to monitor carbon intensity of portfolio assets	Observation Need	Carbon-related analyses
UN16	Nighttime light monitoring	Specific Product	Economic activity and urban development analyses
UN17	Need near real-time tracking of marine vessels to understand their routes and estimate fuel usage	Specific Product	Economic activity and urban development analyses
UN18	Need to monitor crop productivity	Specific Product	Crop analyses
UN19	Identifying types of crops being grown is essential	Specific Product	Crop analyses

8.2.2. GREEN FINANCE

a) Generic Needs

[UN20] Need to consider the cost of data onboarding for high-resolution geo-information

This cost includes acquiring and processing the data, as well as integrating it into their analysis and decision-making processes. It is a relevant factor in determining the feasibility and viability of utilising geoinformation for green finance activities.

[UN21] **Need to combine geoinformation with other relevant (non-geospatial) data sources**

This integration allows for a comprehensive understanding of environmental factors, such as land use, biodiversity, and climate risks, facilitating informed decision-making, and risk assessment of green finance initiatives.

[UN22] **Need to consider the cost of acquiring data from providers**

The cost of data acquisition is an important consideration in determining the overall feasibility of green finance projects. This includes purchasing geoinformation from companies providing EO products and services, or imagery from satellite data providers, plus other relevant datasets required for environmental impact assessments and sustainability analysis.

[UN23] **Need to upgrade the technical knowledge or skills within their organizations**

Appropriate technical skills and knowledge are required to ensure effective utilization of geoinformation and other relevant tools for environmental analysis and decision-making.

[UN24] **Need for awareness raising campaigns**

The lack of information within the Green Finance community about potential specific applications of geoinformation is hindering the uptake of these data and technologies by the sector. Access to information and education about the various uses and benefits of geoinformation helps unlock its potential for sustainable finance activities.

[UN25] **Need for easy-to-interpret EO products for would-be investors in Green Finance mechanisms to ensure efficient aggregation of information**

Enhancing the clarity and accessibility of information enables efficient aggregation of data, promotes investor confidence, and facilitates the growth of green finance activities.

b) Observation Needs

[UN26] **Subdomain: carbon emissions reduction accountability**

Green Finance professionals often need to monitor the greenhouse gas (GHG) emissions of the projects they fund. This helps ensure that the financed activities align with sustainability goals and contribute to reducing carbon emissions, providing transparency and accountability in green finance initiatives.

[UN27] **Subdomain: Project screening (and evaluation)**

For Green Finance workers it is important the need to assess the historical trend and baseline of natural assets. This helps determine the additionality of projects, ensuring that they go beyond business-as-usual practices and deliver tangible environmental benefits.

c) Specific Products

Subdomain: Crop Analyses

[UN28] Green Finance industry professionals identified in the desk-based research phase discussed the need to classify the types of crops being grown in order to assess the sustainability and environmental impact of agricultural investments. Understanding the crop composition helps in evaluating resource usage, potential deforestation risks, and compliance with sustainable practices.

[UN29] Stakeholders from the Green Finance sector express the need to accurately measure the planted area for crops. This allows them to assess the scale and impact of agricultural activities, monitor land use changes, and evaluate the potential environmental risks and benefits associated with specific crops.

[UN30] Stakeholders conducting tree planting initiatives need to monitor and measure the progress of the resulting plantations. This includes the need for monitoring with accurate

measurements the growth and health of trees. Accurate measurements are essential for tracking carbon sequestration, ecosystem restoration, and overall project success.

[UN31] Green Finance professionals need to link tree planting parcels to estimate the number of trees planted. This linkage helps in tracking and verifying the environmental impact of tree planting projects, such as biodiversity enhancement and carbon offsetting, and can provide a powerful marketing tool.

[UN32] Subdomain: Carbon-related analyses

Carbon credits issued for voluntary projects are validated, verified and accredited by carbon credit agencies. Satisfying the initial and ongoing verification requirements of these organisations is a key part of confirming to investors in green projects that their investment is being used appropriately. Thus recognition by voluntary carbon credit agencies and the rating of these credits validates the impact of Green Finance projects in reducing carbon emissions and enables access to additional funding and incentives for sustainable initiatives. Green Finance stakeholders need to achieve recognition by voluntary carbon credit agencies, and to that aim they need to periodically estimate the growth of above-ground carbon stocks (in forests).

Table 8-2 - GEO-INFORMATION NEEDS within the green finance sector

Block 1 - Preliminary information of the needs/requirements			**Block 2 - Traceability and Characterisation**
ID	**User's Expression**	**Definition Level**	**User Subdomain**
UN20	Lower cost of data onboarding and integration for high-resolution geo-information	Generic Need	Cost management
UN21	Need to combine geoinformation with other relevant (non-geospatial) data sources	Generic Need	Data integration
UN22	Need to consider the cost of acquiring data from providers	Generic Need	Cost management
UN23	Need to upgrade the technical knowledge or skills within their organizations	Generic Need	Skills
UN24	Need for awareness raising campaigns	Generic Need	Demonstrations
UN25	Need for easy-to-interpret EO products for would-be investors in Green Finance mechanisms to ensure efficient aggregation of information	Generic Need	Standardisation
UN26	Need to monitor GHG emissions of projects funded	Observation Need	Carbon-related analyses
UN27	Need to assess historical trend and baseline of natural assets	Observation Need	Project screening
UN28	Need to classify the types of crops being grown in order to assess the sustainability and environmental impact of agricultural investments	Specific Product	Crop analyses
UN29	Need to accurately measure the planted area for crops	Specific Product	Crop analyses
UN30	Need for monitoring with accurate measurements the growth and health of trees	Specific Product	Crop analyses
UN31	Need to link tree planting parcels to estimate the number of trees planted	Specific Product	Crop analyses
UN32	Need to periodically estimate the growth of above-ground carbon stocks (in forests).	Specific Product	Carbon-related analyses

8.2.3. RISK ANALYSIS

a) Generic Needs

[UN33] Lack of in-house expert teams to analyse and use geo-information data

Risk analysts expressed lacking the organisational expertise in geoinformation analysis and interpretation that enables more accurate risk assessments and better-informed decision-making processes.

[UN34] **Need larger middle layer of companies able to generate ready-to-use data**

Access to reliable and readily available data is crucial for efficient risk analysis and management. A sufficient supply-side to provide this data and tailor it to the needs of customers is a key demand for the risk analysis sector.

[UN35] **Combination of in situ "ground truths" (data) with geo-information**

Integration of geo-information with data collected by more traditional means provides a comprehensive understanding of risk factors, such as physical characteristics, environmental conditions, or socio-economic factors, enhancing the accuracy and reliability of risk assessments.

[UN36] **Integration of climate risk models and 'value at risk' models**

This allows evaluation of the financial implications of climate-related risks on portfolios and investments, helping in strategic decision-making and risk mitigation.

[UN37] **Projection of risk to portfolio assets into the future**

Enables anticipation of and preparation for potential challenges. This involves considering various risk scenarios, incorporating forward-looking data and trend analysis, and adapting risk management strategies accordingly.

b) Observation Needs

[UN38] **Subdomain: Retrospective Analyses**

Stakeholders working in risk management have identified the need for trustworthy time series of reliable data on assets. This data helps in assessing historical performance, identifying trends, and evaluating the risk associated with specific assets, enabling informed decision-making and risk mitigation strategies.

[UN39] **Subdomain: Biodiversity**

This involves a need to assess the potential impact of business activities or investments on ecosystems and biodiversity, understanding regulatory requirements, and incorporation of biodiversity considerations into risk assessments and mitigation strategies.

Subdomain: Climate change vulnerability

[UN40] Sea Level Rise: Risk Management stakeholders need to monitor the risk of sea level rising threating coastal properties, **infrastructure**, and supply chains, enabling appropriate risk management and adaptation measures.

[UN41] **Increased Temperatures:** Evaluating the potential impacts of climate change, such as monitoring the impact of increased temperatures (heat waves) on asset performance, valuation, and long-term viability.

[UN42] **Droughts:** The increasing frequency and severity of droughts in parts of the world due to climate change drive a need to monitor the impact of droughts on assets among FM sector professionals seeking to understand their risk exposure

[UN43] Understanding changing precipitation patterns and flood risk: This involves evaluating flood-prone areas, assessing vulnerability and exposure of assets, and implementing risk reduction measures, such as flood protection infrastructure or insurance coverage.

[UN44] Increasing occurrence of forest fires drives a need to measure the area vulnerable to wildfires before events,

[UN45] a need to measure the area affected by wildfires after the fact, and

[UN46] a need to measure the intensity of wildfires (level of damage to assets).

c) Specific Products

[UN47] Shifting **climate** conditions and extreme weather events, and the need to understand the impacts of these on existing and future assets implies the need for up-to-date geospatial data on residential and industrial infrastructures' locations.

Table 8-3 - GEO-INFORMATION NEEDS within the RISK ANALYSIS sector

Block 1 - Preliminary information of the needs/requirements			Block 2 - Traceability and Characterisation
ID	**User's Expression**	**Definition Level**	**User Subdomain**
UN33	Need more in-house expert teams to analyse and use geo-information data	Generic Need	Skills
UN34	Need larger middle layer of companies able to generate ready-to-use data	Generic Need	Data integration
UN35	Combination of in situ "ground truths" (data) with geo-information	Generic Need	Data integration
UN36	Integration of climate risk models and 'value at risk' models	Generic Need	Data integration
UN37	Projection of risk to portfolio assets into future	Generic Need	Risk screening
UN38	Need for trustworthy time series of reliable data on assets	Observation Need	Retrospective Analyses
UN39	Need to assess the potential impact of business activities or investments on ecosystems and biodiversity	Observation Need	Biodiversity
UN40	Need to monitor the risk of sea level rise threatening coastal property, infrastructure, and supply chains	Observation Need	Climate change vulnerability
UN41	Need to monitor the impact of increased temperatures on assets	Observation Need	Climate change vulnerability
UN42	Need to monitor the impact of droughts on assets	Observation Need	Climate change vulnerability
UN43	Need to monitor changing precipitation patterns and flood risk in vicinity of vulnerable assets	Observation Need	Climate change vulnerability
UN44	Need to measure the area vulnerable to wildfires before events	Observation Need	Climate change vulnerability
UN45	Need to measure the area affected by wildfires after the fact	Observation Need	Climate change vulnerability
UN46	Need to measure the intensity of wildfires (level of damage to assets)	Observation Need	Climate change vulnerability
UN47	Need up-to-date geospatial data on residential and industrial infrastructures' locations	Specific Product	Asset surroundings characterisation and mapping

8.2.4.INSURANCE MANAGEMENT

a) Generic Needs

[UN48] Regular assessment of risk pricing and policy portfolio

Insurance professionals need to regularly assess risk pricing and policy portfolios to ensure accurate and competitive pricing. This involves analysing market trends, evaluating loss experience, and adjusting premiums and coverage levels accordingly to maintain profitability and manage risk exposure.

[UN49] Collecting field data to calibrate remote sensing geo-information

This data helps ensure the accuracy and reliability of remote sensing data, improving risk assessment models and enhancing underwriting processes.

[UN50] Timely data to keep models useful

Real-time or near-real-time data helps expedite claims processing and improves customer satisfaction by ensuring prompt compensation for covered losses.

[UN51] Guidance to overcome regulatory barriers to the use of satellite-derived geoinformation in insurance

Insurance professionals face regulatory barriers that can hinder the use of satellite-derived geoinformation in insurance processes. Overcoming these barriers, such as

compliance with data protection and privacy regulations, would enable insurers to leverage the benefits of geoinformation for risk assessment and underwriting.

[UN52] Achieving high enough spatial resolution for asset location geoinformation

This level of detail is crucial in determining risk exposure, evaluating property values, and estimating potential losses, enhancing the precision of insurance assessments and pricing.

[UN53] Developing viable business models with cash flow sustained beyond pilot schemes

Challenges remain in sharp focus relating to the scaling up of geoinformation-based insurance solutions, establishing long-term partnerships, and ensuring profitability to drive sustainable growth in the insurance sector. Succeeding in moving beyond these challenges is a key challenge for insurance professionals.

b) Observation Needs

Subdomain: Crop analyses

[UN54] Detecting crop damage at the level of individual farms/fields

Insurance professionals would like to utilise geoinformation and remote sensing technologies to detect crop damage at the level of individual farms or fields. This allows for efficient (and perhaps even automatic) claims processing and accurate assessment of agricultural insurance risks, enabling timely and fair compensation for farmers.

c) Specific Products

Subdomain: Economic activity and urban development analyses

[UN55] For insurance professionals to determine whether the terms of their contracts are being honoured over time, there is a need to detect changes in land use (at the level of individual buildings)

[UN56] To automatically assess risk exposure, help in pricing policies accurately, and evaluate potential changes in insurance coverage requirements, there was a stated need among some insurance management professionals for a tool to automatically update changes in population density estimates based on observable land use changes.

Table 8-4 - GEO-INFORMATION NEEDS within the Insurance Management sector

Block 1 - Preliminary information of the needs/requirements			Block 2 - Traceability and Characterisation
ID	**User's Expression**	**Definition Level**	**User Subdomain**
UN48	Regular assessment of risk pricing and policy portfolio	Generic Need	
UN49	Collecting field data to calibrate remote sensing geo-information	Generic Need	Data integration
UN50	Timely data to keep models useful	Generic Need	
UN51	Guidance to overcome regulatory barriers to the use of satellite-derived geoinformation in insurance	Generic Need	
UN52	Achieving high enough spatial resolution for asset location geoinformation	Generic Need	
UN53	Developing viable business models with cash flow sustained beyond pilot schemes	Generic Need	
UN54	Detecting crop damage at the level of individual farms/fields	Observation Need	Crop analyses
UN55	Need to detect changes in land use (at the level of individual buildings)	Specific Product	Economic activity and urban development analyses
UN56	Automatically update changes in population density estimates based on observable land use changes	Specific Product	Economic activity and urban development analyses

8.3. OVERVIEW OF KEY GEO-INFORMATION REQUIREMENTS

As the last subsection introduced, needs and challenges within the four Financial Management markets under consideration can be aggregated into geo-information requirements that are necessary to address those needs. This subsection attempts to define technical requirements across a range of parameters for those user requirements where this is deemed appropriate.

These requirements are specifically those meeting the needs of the 'Observed Needs' and 'Specific Products' outlined in Section 8.2. They are available in full detail in the accompanying Consolidated User Requirements database.

Table 8-5 - User Requirements: Observation Needs

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
ID	**User's Expression**	**User Domain**	**User Subdomain**	**Area to monitor**	**Spatial resolution**	**Temporal Coverage and Resolution**	**Data throughput**
UN9	Understanding stock levels and monitoring supply chains	Inv. Mgmnt	Stock level and supply chain analyses	Storage facilities and single-sites - 1km x 1km	10m x 10m	High refresh rate to understand rate of change. Historical period to be covered highly case-dependent.	Very quick tasking and data availability for analysis
UN10	Need to understand population density when making investment decisions	Inv. Mgmnt	Population analyses	Districts within a city - 1km x 1km	Building-level	Low refresh rate needed, multiple years of historical data useful for model calibration	Low need for rapid tasking or data availability
UN11	Realistic assessment of accessibility to assets	Inv. Mgmnt	Asset surroundings characterisation and mapping		Hundreds of metres - relevant pixels for e.g. flood risk		
UN12	Analysis of potential risks in specific regions	Inv. Mgmnt	Asset surroundings characterisation and mapping	Project location	Project asset level	Dependent on risk level - length of coverage need is higher if determined in high risk situation	High need for rapid data availability
UN13	Need to geo-map clients	Inv. Mgmnt	Risk screening	Business operational geography	Building-level	Dependent on risk level - length of coverage need is higher if determined in high risk situation	
UN14	Need to screen the feasibility of projects against different hazards criteria	Inv. Mgmnt	Project screening	Project location	Project asset level	Dependent on hazard risk level - length of coverage need is higher if determined in high risk situation	Tasking and data availability required to be sufficient to feed into screening and decision process

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
UN15	Need to monitor carbon intensity of portfolio assets	Inv. Mgmnt	Carbon-related analyses	Asset location	Asset level	Multi-year coverage, high refresh rate to capture different phases of asset use	Data availability sufficient for regular reporting cycles
UN26	Need to monitor GHG emissions of projects funded	Green Finance	Carbon-related analyses	Project location	Project asset level	Multi-year coverage, high refresh rate to capture different phases of asset use	Data availability sufficient for regular reporting cycles
UN27	Need to assess historical trend and baseline of natural assets	Green Finance	Project screening	Asset location	Asset level	Multi-year coverage, variable refresh rate depending on type of natural asset	Data availability sufficient for regular reporting cycles
UN38	Need for trustworthy time series of reliable data on assets	Risk Analysis	Retrospective Analyses	Asset location	Asset level	High need for historical data to calibrate predictive models	Low need for rapid tasking or data availability
UN39	Need to assess the potential impact of business activities or investments on ecosystems and biodiversity	Risk Analysis	Biodiversity	Wide area around business assets	High requirement for precise spatial resolution	Annual coverage and medium refresh rate to ensure full understanding of seasonal changes in ecosystem monitored	
UN40	Need to monitor the risk of sea level rise threatening coastal property, infrastructure, and supply chains	Risk Analysis	Climate change vulnerability	Asset location	Asset level	Low need for temporal resolution, high need for long term coverage to understand trends	Low need for rapid tasking or data availability
UN41	Need to monitor the impact of increased temperatures on assets	Risk Analysis	Climate change vulnerability	Asset location	Asset level	Low need for temporal resolution, high need for long term coverage to understand trends	High need for rapid tasking and data availability following damaging events
UN42	Need to monitor the impact of droughts on assets	Risk Analysis	Climate change vulnerability	Asset location	Asset level	Low need for temporal resolution, high need for long term coverage to	High need for rapid tasking and data availability following

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
						understand trends	damaging events
UN43	Need to monitor changing precipitation patterns and flood risk in vicinity of vulnerable assets	Risk Analysis	Climate change vulnerability	Asset location	Asset level	High need for historical data to calibrate predictive models	Low need for rapid tasking or data availability
UN44	Need to measure the area vulnerable to wildfires before events	Risk Analysis	Climate change vulnerability	Asset location	Asset level	High need for historical data to calibrate predictive models	Low need for rapid tasking or data availability
UN45	Need to measure the area affected by wildfires after the fact	Risk Analysis	Climate change vulnerability	Asset location	Asset level	High need for small amount of historical data for pre-event comparisons	High need for rapid tasking and data availability following damaging events
UN46	Need to measure the intensity of wildfires (level of damage to assets)	Risk Analysis	Climate change vulnerability	Asset location	Asset level	High need for small amount of historical data for pre-event comparisons	High need for rapid tasking and data availability following damaging events
UN54	Detecting crop damage at the level of individual farms/fields	Insurance Mgmnt	Crop analyses	Entire agricultural region - 100s of square km	Individual farm level	High need for small amount of historical data for pre-event comparisons	High need for rapid tasking and data availability following damaging events

Table 8-6 - User Requirements: Specific Products

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
ID	**User's Expression**	**User Domain**	**User Subdomain**	**Area to monitor**	**Spatial resolution**	**Temporal Coverage and Resolution**	**Data throughput**
UN16	Nighttime light monitoring	Inv. Mgmnt	Economic activity and urban development analyses	Regions within a country	10s to 100s of meters	Low refresh rate needed, low temporal coverage needed	Low need for rapid tasking or data availability
UN17	Need near real-time tracking of marine vessels to understand their routes and estimate fuel usage	Inv. Mgmnt	Economic activity and urban development analyses	Entire shipping routes / seas likely to sail in	10s of meters	High temporal resolution allows better route approximations. Constant coverage required for duration of analysis.	Need real-time tracking but low data availability need

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
UN18	Need to monitor crop productivity	Inv. Mgmnt	Crop analyses	Entire agricultural region - 100s of square km	Individual farm level	Annual coverage, greater refresh rate at key planting / harvesting periods	High need for rapid tasking and data availability to onboard new fields
UN19	Identifying types of crops being grown is essential	Inv. Mgmnt	Crop analyses	Entire agricultural region - 100s of square km	Individual farm level	Annual coverage, higher refresh rate at key planting periods	High need for rapid tasking and data availability to onboard new fields
UN28	Need to classify the types of crops being grown in order to assess the sustainability and environmental impact of agricultural investments	Green Finance	Crop analyses	Entire agricultural region - 100s of square km	Individual farm level	Annual coverage, greater refresh rate at key planting / harvesting periods	
UN29	Need to accurately measure the planted area for crops	Green Finance	Crop analyses	Entire agricultural region - 100s of square km	Individual farm level	Annual coverage, higher refresh rate at key planting periods	High need for rapid tasking and data availability to onboard new fields
UN30	Need for monitoring with accurate measurements the growth and health of trees	Green Finance	Crop analyses	Entire forests - 1000s of square km	Individual farm level	Regular monitoring throughout year with low refresh rate	Low need for rapid tasking or data availability
UN31	Need to link tree planting parcels to estimate the number of trees planted	Green Finance	Crop analyses	Entire forests - 1000s of square km	Tree-level; a few metres	Regular monitoring throughout year with low refresh rate	Low need for rapid tasking or data availability
UN32	Need to periodically estimate the growth of above-ground carbon stocks (in forests).	Green Finance	Carbon-related analyses	Entire forests - 1000s of square km	Tree-level; a few metres	Higher refresh rate in regions of faster growth (e.g. tropics); quarterly in colder climates, monthly or more regular elsewhere	Low need for rapid tasking or data availability
UN47	Need up-to-date geospatial data on residential and industrial	Risk Analysis	Asset surroundings characterisation and mapping	Business operational geography	Building-level	Low refresh rate needed, low temporal coverage needed (to match changes	Low need for rapid tasking or data availability

Block 1 - Preliminary information of the needs/requirements		Block 2 - Traceability and Characterisation		Block 3 - Technical Requirements			
	infrastructures' locations					in asset locations)	
UN55	Need to detect changes in land use (at the level of individual buildings)	Insurance Management	Economic activity and urban development analyses	Business operational geography	Building-level	Low refresh rate needed, multiple years of historical data useful for model calibration	Low need for rapid tasking or data availability
UN56	Automatically update changes in population density estimates based on observable land use changes	Insurance Management	Economic activity and urban development analyses	Insured area	Building-level	Low refresh rate needed, multiple years of historical data useful for model calibration	

9. CONCLUSION

This report focuses on gathering key user needs, challenges, and geo-information requirements of the Financial Management (FM) sector. All four FM domains considered (Investment Management, Risk Analysis, Green Finance, and Insurance Management) are highly dependent on information to efficiently carry out their roles in the broader financial ecosystem. Geoinformation is increasingly viewed as one source of alternate data to drive further improvements across these domains.

In our attempt to obtain the most recent and relevant information directly from Financial Management professionals, four distinct activities were undertaken.

Firstly, an extensive desktop review was conducted to examine geospatial data in the financial sector, identify the drivers behind the demand for spatial finance, and pinpoint potential stakeholders in this field. Secondly, a workshop was organized to gather feedback, thoughts, and valuable contacts from stakeholders operating within this space. Thirdly, a series of semi-structured one-to-one interviews were carried out with stakeholders from the private, public, and third sectors. The aim was to unravel and gain a deeper understanding of geospatial pain points, opportunities, as well as user needs and requirements. Finally, a synthesis task was carried out to consolidate this information, improve it via the review of a Stakeholder Board review process, and report it publicly for further comment and dissemination of useful findings. Section 8 of this report presented outputs from the consolidated User Requirements database, and so highlights the expressed user needs coming from the research phases. These user needs were classified into four definition levels.

In addition to these important findings of expressed user needs, a few overarching themes became apparent during the activity. Below we describe the most important observations in this vein.

- **Security around corporate secrets**
  - Many of the Financial Management professionals invited to participate in this project explained that they were unable to do so on account of internal corporate policies regarding sharing information on their data sources, analysis methods, and projects to improve business processes. Corporate secrets, especially those from which a company derives a significant benefit, are jealously guarded. This is reflected in our information sources, with some bias towards institutional organisations who are more open in this regard, and hence likely some bias toward the same organisations' perspectives in our findings. This lends further support to the importance of the sharing of best practices uncovered as part of this project.
- **Needs bounded by known constraints**
  - Among those willing to speak candidly, the researchers discovered a strong tendency to base statements about geoinformation product and service needs on their knowledge of technical possibility. This (likely subconscious) restraint meant that it was particularly difficult to elicit user needs that centre on geoinformation products and services that do not currently exist in the market. The result was a bias towards responses that focus on aspects of needs aside from technical capabilities.
- **Skills and training**
  - Chief among the non-technical user needs expressed was a way to bridge the current skills gap that exists between the Financial Management sector and geoinformation. Stakeholders identified a lack of an existing skills base, inadequate training material, limited financial resources to fund staff development, and a significant demand for 'pre-processed' and 'insight-ready' geoinformation to sidestep these issues in the short run.

This report shall enable the wider EO industry to tailor their development of products and services to real user needs and pain points, as identified throughout. A further analysis of the current challenges of users and the corresponding EO capabilities that exist today and in the near-future will be provided in a future deliverable from this same project. This future report will link challenges to capabilities and also identify gaps in the current EO capabilities portfolio.

ANNEX A.

This annex includes the agendas for each of the workshop days.

A.1. THURSDAY 16TH FEBRUARY

Spatial Data for Financial Management Workshop A 16/2/2023 - 14:00-16:00 GMT		
SESSION 1 - Opening		
Time (GMT)	**m**	**Topic**
14:00 - 14:05	5	Welcome and Introduction to project
14:05 - 14:15	10	Project context, summary, and Workshop objective
SESSION 2 - Investment Management		
Time (GMT)	**m**	**Topic**
14:15 - 14:25	10	Presentation of Investment Management topic area, current state of our findings, any points of interest
14:25 - 14:45	20	Guided discussion in breakout rooms
14:45 - 14:55	**10**	**Comfort break**
14:55 - 15:00	5	Session wrap-up with summary across breakout rooms
SESSION 3 - Green Finance		
Time (GMT)	**m**	**Topic**
15:00 - 15:10	10	Presentation of Green Finance topic area, current state of our findings, any points of interest
15:10 - 15:30	20	Guided discussion in breakout rooms
15:30 - 15:40	**10**	**Comfort break**
15:40 - 15:45	5	Session wrap-up with summary across breakout rooms
SESSION 4 - Conclusions		
Time (GMT)	**m**	**Topic**
15:45 - 15:50	5	Session 2 & 3 Wrap-up
15:50 - 16:00	10	Next steps
16:00		**Meeting Close**

A.2. FRIDAY 17TH FEBRUARY

Spatial Data for Financial Management Workshop B 17/2/2023 - 14:00-16:00 GMT		
SESSION 1 - Opening		
Time (GMT)	**m**	**Topic**
14:00 - 14:05	5	Welcome and Introduction
14:05 - 14:15	10	Project context, summary, and Workshop objectives
SESSION 2 - Risk Management		
Time (GMT)	**m**	**Topic**
14:15 - 14:25	10	Presentation of Risk Management topic area, current state of our findings, any points of interest
14:25 - 14:45	20	Guided discussion in breakout rooms
14:45 - 14:55	**10**	**Comfort break**
14:55 - 15:00	5	Session wrap-up with summary across breakout rooms
SESSION 3 - Insurance		
Time (GMT)	**m**	**Topic**
15:00 - 15:10	10	Presentation of Insurance topic area, current state of our findings, any points of interest
15:10 - 15:30	20	Guided discussion in breakout rooms
15:30 - 15:40	**10**	**Comfort break**
15:40 - 15:45	5	Session wrap-up with summary across breakout rooms
SESSION 4 - Conclusions		
Time (GMT)	**m**	**Topic**
15:45 - 15:50	5	Session 2 & 3 Wrap-up
15:50 - 16:00	10	Next steps
16:00		**Meeting Close**

ANNEX B.

Table B-1 - Swiss Re's summary of primary use cases of remote sensing in insurance

Value chain	Line of business	Use case	Remote sensing technology	Benefits	Challenges	Future applications
Claims assessment	Agriculture	Crop yield estimation to assess and settle claims.	Smart sampling enabled by both passive and active (SAR) remote sensing.	Less manpower required to estimate yields. Reliable sampling and cost saving.	Establishing correlation between remote sensing vs historical yield data.	Risk assessment, early warning for preventable crop losses.
Claims assessment	Property	Rapid damage assessment after large scale flood events.	Flood maps enabled by both passive and active (SAR) remote sensing.	Faster decisions on claim admissibility and settlement Better reserving and lower moral hazard	Measuring peak flood height and time for which water stands still.	Loss prediction and risk monitoring. Deployment and planning of claims adjusters to detect affected policy owners
Underwriting and claims assessment	Property	Detecting severity of roof and building structure damage.	Passive (aerial) imagery analysed with semantic segmentation	Faster underwriting. Better reserving and lower moral hazard	Aerial imagery can be costly and difficult to acquire at short notice.	Property loss prediction and risk monitoring.
Claims assessment	Property	Subsidence loss assessment and prediction for sinking structures	Active (Differential Interferometric Synthetic Aperture Radar or D-InSAR) images analysed over long time	Faster decision on claim admissibility and settlement	Hard to achieve higher temporal resolution across different generation of satellites	Landslide and subsidence risk assessment and monitoring
Product development	Agriculture	Crop parametric product for drought risks based on soil moisture index.	Passive (microwave) images to measure soil moisture levels.	Automated underwriting and payout. More comprehensive than Normalized Difference Vegetation Index (NDVI) and rainfall index.	More customisation required for adjusting the index to crop type and sowing stage.	Similar products for pasture or yield based crop insurance
Product development	Property	Property (Flood) parametric product based on excess rainfall index.	Passive remote sensing images combined with data from ground-based weather stations.	Affordable product with automated underwriting and payout. Longer time series of weather data.	High basis risk. Not suitable for single location risk and retail customers.	New wind parametric products using data from satellites such as Aeolus.

SOURCE: SWISS RE INSTITUTE. (2021). 'REMOTE SENSING INNOVATION: PROGRESSING SUSTAINABILITY GOALS AND EXPANDING INSURABILITY'

END OF DOCUMENT

TEMPLATE 23/11/2020