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Scottish Enterprise -

International Inward Investment in Scotland for the Downstream Space Data Market

SCOTTISH DEVELOPMENT INTERNATIONAL

Scottish Enterprise

ASTROAGENCY®

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Executive Summary

Space data, covering a wide remit of the space downstream industry, continues to provide a sizeable segment of the Scottish space sector -a segment in which Scottish space companies have developed international expertise and commercial export success. Previous reports undertaken by AstroAgency for Scottish Enterprise and SDI, have laid out the Scottish space capabilities in Scotland around space data analysis, and specific markets for Scottish space data analysis such as agriculture. Notably, in a previous study compiled for Scottish Enterprise, "Key Export Market Opportunities - International Mapping and Benchmarking of Downstream Space Companies".

The purpose of this report is to provide information useful for Scottish Enterprise's Global Investment Team, in order for them to target companies for their Scaling and Innovation Mission (SIM). From a space perspective, a broad understanding of the wide spread of corporate consumers of commercial space data was needed. In this case, from the perspective of the downstream opportunities, identifying and prioritising the space sector areas where end user sectors are known, was deemed to be the most appropriate approach. This would then help fulfil the potential for downstream inward investment in Scotland's space and adjacent sectors such as Fintech, Agritech, Maritime and Energy, and international equivalents to be highlighted. For instance, the food industry is often overlooked, but from previous projects undertaken by AstroAgency around Earth Observation, data analysis and agritech, it is apparent that there are very large food aggregator companies that are reliant on high quality space analysed downstream data. However, sectors that use Positioning and Location Data are overlooked to an even greater extent, yet space data in the location and navigation markets is extremely widely used.

Previous analysis has shown that the downstream segment of the space industry related to space data, especially Earth Observation and wider satellite derived Position, Navigation and Timing data, as used for applications such as those involving geospatial data, are areas of the space industry that not only have a realisable economic return and can help catalyse growth, but provide positive environmental and societal returns, most notably in sustainability, where they provide valuable insights into climate change which can help the transition to Net Zero. The Earth Observation space data and Position, Navigation and Timing space data sectors have much lower entry barriers in terms of capital requirements, and consequently, offer a more rapid return on investment, but only if the correct markets are addressed.

Some of the companies in the wider non space markets have noticed the value that space data provides, and have become active users of space data. Others present new opportunities for using space data. This research identifies a number of companies in these industries and sectors for engagement by Scottish Enterprise's Global Investment Team, and where the potential for collaboration between potential inward investing companies and Scottish space data companies exists, indicates potential companies in Scotland with space data expertise around downstream data analysis and geospatial, can translate into opportunities to engage with the global market for space data in order to galvanise inward investment.

- Natural Capital
- Agritech
- Maritime and Aquaculture
- Fintech
- Utilities
- Transport and Logistics
- Mining
- Health and Wellness
- Construction
- IT

Each of these industries break down into a myriad of subsectors, and those that are deemed most relevant for this study are described and evaluated to identify companies working within their area.

Companies were identified in terms of geographical regions, and whilst an initial scope was set for potential countries and geographies, it was seen that whilst the regions specified would form the core regions of interest, the scope should expand to cover:

- US & Canada
- Europe
- MEA
- East Asia
- Australia

The reason for this is based on extensive knowledge of the global space market, and of players who are likely to be of interest, AstroAgency was aware of opportunities beyond the initial remit, and the fact that companies that use or could use space data would often be in these other regions. Thus, the importance of the geographical regions became subservient to the identification of suitable companies from across the whole of the regions identified.

Initially, it was anticipated that this would be a logical approach based on extensive knowledge of the global space market, and of players who are likely to be of interest, with the methodology supporting an approach that filters based on markets, geographical location, and finally company, however, the focus on the company aspect to a greater extent than the geographical region, was a process that developed organically during the research process, and resulted in the research being a lot more directly targeted on potential companies, with their regional location becoming more of a by-product.

AstroAgency has used its approach of desk-based research, leveraged with extensive non-space databases that have been developed through previous work with industry associations and downstream companies outside of the space industry. The existing data that has been gathered regarding external industries outside of space, has been essential to provide an insight into how space data is used, where it is used in an international context and why it is used by companies outside of the space industry. AstroAgency was still able to leverage country data to find relevant companies however, since they were logged on AstroAgency's proprietary space data research database.

Previous research has looked at the natural capital / natural asset sector, e.g., forestry industry companies, peat related initiatives, Carbon asset observation monitoring, reporting and verification (OMRV), as well as the agriculture sector, e.g., food security (aquaculture, agricultural based: food aggregators, and food producers such as crop growers), however, this was not a deep dive into the applications of space data or the end user companies for the previous studies. This research has aimed to help deepen the level of knowledge and broaden the understanding of the companies engaged in these sectors.

AstroAgency already conducts analyses for its clients which always includes a study of market penetration, market opportunity, and market accessibility – vital factors that are often overlooked. In this report, the traffic light analysis approach is again applied to highlight these factors for each country and each area of space data use, providing a more easily digestible report that can be used by Scottish representatives in the various countries identified.

1. Introduction

1.1 Scope

The scope of the report covers the evaluation and gathering of information relevant to building up intelligence on international end users who make existing use of space data or could benefit from using space data, and who would be amenable to inward investment into Scotland in the context of space data.

In this context, space data refers to Earth Observation space data or Earth Observation space data, as well as Position, Navigation & Timing space data, communications space data as well as specialist space data areas such as meteorology.

The scope for a report of this type needs to cover Earth Observation, Position, Navigation & Timing, and communications, in order to account for the wide range of space data applications that are consumed by end users.

1.2 Purpose and objectives

The purpose of this report is to provide information useful for Scottish Enterprise's Global Investment Team, in order for them to target companies for their Scaling and Innovation Mission (SIM). From a space perspective, a broad understanding of the wide spread of corporate consumers of commercial space data was needed. In this case, from the perspective of the downstream opportunities, identifying and prioritising the space sector areas where end user sectors are known, was deemed to be the most appropriate approach.

The primary objectives against which the success of the project shall be judged are:

- Identify end users of space data in each of the specified countries, across a range of space data segments including earth observation, Position, Navigation & Timing, as well as space communications.
- Where possible, Identify the types and specifications of space data the end users make use of.
- Identify which geographic markets should be prioritised for exploring in terms of trade opportunities for drawing in inward investment into Scotland.
- Identify industries that use space data, and indicate how they use the space data, extending, if possible, to what datasets they use.
- Identify companies that would benefit from using space data, even if they are not currently using space data.

1.3 Definitions and Terminology

At a top level of categorisation, the space sector is generally split into either what is referred to as the upstream segment or the downstream segment. Sometimes, a further category called midstream is referred to, although this term is less frequently used.

Space upstream entails hardware or infrastructure, and refers to the supply chain that enables launch activity or satellites, spacecraft and any other space-based infrastructure. This includes the manufacture and launch of rockets, the design or manufacture of satellites and sub-systems of both launch vehicles and satellites, as well as the ground support infrastructure, including spaceports.

Space downstream in the context of this report specifically means companies that harness the data that is transmitted from satellites to the Earth for a wide range of uses. The applications for downstream are effectively unlimited, and thus this is a segment of the space sector that has tremendous growth potential over and above the upstream segment. Downstream companies are predominantly software based, frequently combining data with artificial intelligence/machine learning to enhance the insight provided.

Midstream is a term that is occasionally used to refer to satellite ground stations, and associated hardware and equipment.

Remote Sensing is defined as the acquisition of information about an object or phenomenon without making physical contact with the object or phenomenon.

Whilst it can be performed using ground based and aerial remote sensing, in this context, and more generally in the space sector, it refers to remote sensing from space, and for this reason, is often referred to as satellite Remote Sensing (also known as space-based Earth Observation) or space-based Remote Sensing (which additionally can cover use with other objects such as planets, moons, asteroids and comets).

Remote Sensing uses a wide variety of sensors ranging from active and passive imaging (Optical, Infra-Red, Multispectral, Hyperspectral, Synthetic Aperture Radar (SAR), Polarimetry) or point measurements (LIDAR, spectrometry, Radar Altimetry, multispectral radiometers, solar occultation sensors and microwave limb sounders) or field measurements (gravimetry, magnetometry and RF measurements). These sensors can be fitted to cameras, telescopes or bespoke instrumentation.

Earth Observation (EO) is defined as the process of acquiring observations of the Earth's physical, chemical, and biological systems on the surface, below the surface and in the atmosphere via remote sensing instruments. Earth Observation is effectively a subset of space based Remote Sensing. The type of satellite used for Earth Observation generally (but not exclusively) operates in Low Earth Orbits, a couple of hundred kilometres above the Earth, in order to provide sufficiently high resolution for sensors such as optical, infra-red or radar.

Space Applications refer to directly acquiring, analysing, processing or modifying satellite data. An example of a space application would be the imaging (optical or otherwise) across two dates, of an area of forest, or the measurement of the change in the number of trees from data taken across two dates of an area of forest

Space Services refer to the discovery or use of actionable and commercial insights from data acquired from space/satellites which result as an outcome of using space applications data (i.e., they do not 'touch' the actual data). An example of a space service would be the calculation of the carbon assets resulting from imaging data of a forest, or the calculation of the change in carbon assets resulting from data recording the change in the number of trees across two dates of an area of forest.

It should be noted that some companies can be both Space Application and Space Services companies.

Earth Observation space data refers to data acquired from Earth Orbiting satellites specialising in imaging of the Earth. This definition also refers to data derived for the purposes of analysis, processing or modification with regard to generating commercial value from the data.

Space data users or **end users** refers to any company, organisation or other entity outside the space sector who use space data as part of their services or products.

Data provider refers to any company, organisation or other entity that provides EO data directly or as part of a service or product.

Position, Navigation and Timing (PNT) space data refers to data acquired from Earth orbiting satellites designed to provide accurate position and timing signal data (e.g., using the data to enable navigation i.e., for the US's GPS, the EU's Galileo, Russia's GLONASS and China's Beidou GNSS).

Global Navigation Satellite System (GNSS) is a term to specifically describe a use of PNT in the form of a satellite navigation system with global coverage. This means a collection of satellites orbiting the Earth (a satellite constellation), specifically to support navigation of terrestrial users on the land, sea and in the air. There are 4 operational global systems: the United States's Global Positioning System (GPS), Russia's Global Navigation Satellite System (GLONASS), China's Navigation Satellite System (Beidou), and the European Union's Galileo.

Regional Navigation Satellite System (IRNSS) is a term to describe a satellite navigation system with regional coverage. Examples of operational RNSS include Japan's Quasi-Zenith Satellite System (QZSS), and India's Indian Regional Navigation Satellite System (IRNSS) - known as NavIC.

Geospatial is a term used to describe the combination of PNT data (specifically GNSS data) and Earth Observation space data to provide data driven insights. Geospatial data can apply to PNT data / GNSS data in singular form too, but more often than not, it refers to the combination with Earth Observation data.

RTK refers to the term Real Time Kinematics, which is used to describe a development from GNSS, most notably GPS. It can provide 1cm accuracy with a precision of 0.1mm

Inward Investment refers to any economic investment from outside of the country (i.e. from another country), that is invested into the country. This can take the form of direct funding or funding for infrastructure or to existing operators.

1.4 Document Structure

Following the executive summary, the document is divided into a number of sections that are briefly described below:

EXECUTIVE SUMMARY This section provides context for the report, the purpose for which the report was commissioned, and a summary of the conclusions and recommendations.

1 INTRODUCTION In this section, the report is placed in context regarding the background and scope, the report's purpose and objectives are defined, and the structure of the document is outlined.

2 APPROACH / METHODOLOGY This section describes the approach taken to fulfil the requirements of the final analysis and how the analysis was executed.

3 THE MARKET FOR SPACE DATA – AN OVERVIEW This section provides an introduction to the topic of space data, what it is, why it is used, how it is used.

4 THE MARKET FOR SPACE DATA BY SECTOR This section presents an overview of the imdustry sectors evaluated for this report.

5 THE MARKET FOR SPACE DATA BY GEOGRAPHICAL REGION This section indicates the extent of the markets for space data usage and space data end users in the geographical regions specified for this study. This is a high-level look at the regional markets, in order to provide context for the companies, and to build on the industry sectors highlighted in the market for space data in section 4.

6 COMPANIES This section highlights the individual companies deemed to be of potential interest to develop new opportunities in terms of inward investment.

7 CONCLUSIONS This section presents the results, findings and insights generated by the report.

1.5 Exclusions

The report is principally focused on commercial space data uses, rather than academic or defence related space data uses. The market for space data use is vast, and consequently the individual markets into which space data could and is being used has to provide a snapshot of the potential as opposed to detailing every single category and application.

2. Approach & Methodology

The approach for this project was to expand the opportunity envelope for inward investment through researching the space data users in the various geographical regions identified, and in the industries defined.

2.1 Research

The method by which this was undertaken was to apply online, desktop research using publicly available data sources in a similar mode to Open Source Intelligence. AstroAgency's standard methodology for the research stage breaks down into the following steps:

Review Existing Information: The research stage starts by reviewing existing sources of information, to include AstroAgency's internal databases.

Desk Based Research: Sources of information including papers, books, handbooks and other literature along with company websites and sector reports and directories are then reviewed to find relevant and useful data on companies and addresses.

2.2 Filtering

Information gathered through the research needs to be filtered. For end users using space data, this can present a challenge because they may not even realise, they use space data themselves! Similarly, for end users who could benefit from using space data, identifying them is based on drawing from previous analysis and contact with experts in other industries.

2.3 Analysis

Analysis of the data researched in the context of space data end users, relies on knowledge of the industries covered, and known use of space data in those sectors, since this offers a starting point for evaluating companies that are active within that industry. As the analysis progresses, the report is expanded to accommodate information on the individual companies.

3. The Market for Space Data – An Overview

3.1 What is Space Data? A Space Data Market Definition

Space data is information provided from satellites orbiting the Earth. Initially, in the early development of the space industry, this information could be in an analogue format such as hard copy photographs returned from space in re-entry capsules, or information transmitted by systems similar to fax machines.

From the early 1990s, the development of new, digital technologies transformed the use of data returned from space, driving the growth of the space data industry from a niche area mainly used for academic research or the military, to today's widespread use of digital data for monitoring the Earth, communicating with sensors or with high bandwidth streams of data, meteorology or enabling vehicles and people to accurately navigate and never get lost.

Whilst these are direct space industry developments, it is the data that is enabled from these developments that results in new applications in sectors often far removed from the space sector.

3.2 Why is Space Data Used? The Space Data Market Landscape

Previously, visiting a new location required using a map, and for more remote locations, may even require a compass. Nowadays, travelling from Point A to B occurs seamlessly using signals transmitted from space to a personal or vehicle receiver, which enables the triangulation of a person, vehicle or an object's location, whether stationary or in motion. This is referred to as either Satellite Navigation (SatNav), or by the more technical term, Global Navigation Satellite System (GNSS), or Global Positioning System (GPS), and falls under the more extensive space data segment of PNT (Position, Navigation and Timing). Examples of how this type of satellite data is used on a day-to-day basis include:

Transport and logistics: For the transport and logistics industry, using these satellite signals to more accurately guide a journey, can help save considerable fuel costs and help reduce emissions.

Fintech / Insurance: An insurance loss adjuster would have to walk around a site, undertake a site survey, in often challenging conditions, whereas now, they can order a high-resolution satellite map of a site, and even view the site using space data at different wavelengths to identify any subtle changes not seen by the human eye. For the insurance industry, this saves money not only in terms of the site survey, but in terms of identifying potential future insurance needs.

Agritech: A farmer would previously need to spray fertiliser on a field by eye, whereas now, satellite positioning data ensures that they can achieve even and full coverage of their crop spraying, and they can even order a satellite image of the field to check that the fertiliser has been evenly distributed. For the agricultural industry, this results in efficiency improvements, reducing cost that would be incurred by needing to respray any areas of a field that might have been missed, with knock-on effects in terms of extra fuel consumption and loss of precious time.

3.3 How is Space Data Used?

There are a wide variety of ways that space data is used, but they can be broadly broken down into a number of distinct areas:

1. Earth Observation (EO):
    - Environmental monitoring / Climate Change
    - Agriculture
    - Natural Capital (Forestry, Peatland, Estates)
    - Disaster response
    - Urban planning
2. Positioning, Navigation & Timing (PNT):
    - Navigation (e.g., GNSS services for Fleet tracking, Autonomous vehicles, Emissions monitoring)
    - Positioning (e.g., Surveying, Construction)
    - Timing (e.g., clock signals for utilities)
3. Satellite Communications:
    - Broadband Data Internet connectivity
    - Narrowband Data Connectivity (the Internet of Things)
    - Telecommunications
    - Broadcasting
4. Scientific Research:
    - Space weather monitoring
    - Climate science
    - Astronomy and Astrophysics
5. Defence, Security & Intelligence:
    - Surveillance
    - Reconnaissance
    - Border or facility monitoring

Scotland is particularly strong on Earth Observation space data analysis, with over 30 space data companies. Although awareness is lower, Scotland also has space data strengths in the other areas too, with satellite companies such as Glasgow based Spire and AAC ClydeSpace also providing commercial data services in areas such as Narrowband Data and Intelligence, Surveillance & Reconnaissance.

3.4 Space Data Market Segmentation

The market for space data can be segmented in a variety of ways (by application, by user type, by wavelength, by data type), however, in this case, the end users are primarily commercial and government (other end users would include academia and defence). In this context, the market segmentation is broken down into the applications for which it is used, i.e., industry sectors. There are a myriad of sectors that can be included, however for the purpose of this research, the following markets are considered:

- Natural Capital
- Agritech
- Maritime and Aquaculture
- Fintech
- Energy / Utilities
- Transport and Logistics
- Mining
- Health and Wellness
- Construction
- IT

3.5 Space Data Market Segment Examples

3.5.1 PNT (Position, Navigation and Timing)

The PNT industry operates across commercial, defence and civilian markets, providing an integral role in Critical National Infrastructure sectors around the world. Within the PNT industry, the Global Navigation Satellite System (GNSS) downstream market revenues from both device and service sales are around £223bn in 2023, with revenues from smartphone apps representing an important component, amounting to over 60% of added-value services, and over 40% of the total revenues. The UK total share of the devices and services market is around £1.7bn, with a £1bn export market, however, this does not give a true indication of the scale of the UK market, since the GNSS services support £320bn of UK GDP (15.3%).

The Space Based Positioning, Navigation and Timing Programme (SBPP) was launched by the UK Space Agency in October 2020 to explore new ways to deliver vital satellite navigation and timing space data services to the UK from space. The development is being undertaken by leading UK and international space companies Airbus, CGI, Sirius Analysis, GMV NSL, Inmarsat, and QinetiQ.

The PNT sector also includes large multinationals from beyond the space industry such as Intel and BAE Systems, as well as Roke, u-blox, Chronos Technology, JCB, Zencic, Fugro, Veripos, Spirent and SatixFy.

3.5.2 Earth Observation

The number of EO satellites and sensors have increased significantly in recent years and the technology itself has advanced. UK Companies such as Space Intelligence, Ecometrica, Earth Blox and Earth-I provide invaluable insights from space that help companies make decisions regarding carbon offsets, whilst others like Trade in Space help provide assurance for the sustainability of products like agricultural commodities using EO data, and additionally, at the upstream end of the market, new Carbon monitoring satellites are currently being built for Canadian company GHGSat in Glasgow by Spire Global, with Spire also collaborating with Skyline Partners to use EO for MRV for the insurance market.

Carbon Offsets that are traded in the Carbon markets need to have a formal level of assurance to ensure there is no greenwashing in the supply chain. The method that is being adopted to achieve this is MRV - Monitoring Reporting Verification. Orbital monitoring provides data over a period of time that enables analysis of climate change impacts.

With the growth in use of Earth Observation for applications such as MRV, there is also an increasing use of AI and Machine Learning, to analyse large data sets at scale, and derive critical information to provide insights. Scotland's strengths in data analytics, and more recently secure quantum space technology, will be able to be applied to a greater extent to Earth Observation applications, especially those where accuracy for identification of surface features is required, such as MRV. This presents a major benefit for international companies.

3.5 Space Data Addressable Markets

It has been noted in previous reports, that whilst within the space sector, data analysis and data insight companies are well known, the much larger number of companies that use space data or could use space data outside of the space sector is more challenging, since they are not only part of the space industry, but rather have their own specific verticals (agritech, insurtech, climatetech etc.). This is both a challenge and an opportunity, since it indicates the many new uses to which space data is being applied.

Commercial examples of space data use include insurance giant Aon and agriculture market leader Bayer establishing partnerships with Earth Observation satellite companies ICEYE and Planet respectively, as well as Raincoat, a parametric insurance provider, and Munich Re Group which is launching a flood insurance product - all expanding into the application segment of the space data market.

In all cases, the business opportunity is around how space data can benefit the end users in terms of helping them get their job done or how it can positively benefit the end users bottom line. The side effects of this can even extend to contributing to solving larger environmental, societal, and economic challenges.

3.5.1 Space Data Market Trends and Total Addressable Market

The total addressable market (TAM) for space data is seeing significant growth, driven by technological innovations and expanding applications across various sectors. As both space-based satellite technology and ground-based technology (such as smart phones with direct satellite connections) becomes more accessible, and as data analytics capabilities advance, especially with the advent of big data, AI and the expansion of data centres, the use of space data is expected to become increasingly integral to both governmental and commercial operations worldwide.

The rise of the EO application market is being accelerated by added-value services (e.g., applications), which represent the largest market, with revenues estimated to account for €2.8 billion in 2023 and expected to grow to almost €5 billion by 2033, experiencing a CAGR of 4-6%. Revenues from EO data sales amounted to around €600 million in 2023 and are set to increase to almost €1 billion in 2033.

In 2023, in terms of the geographical distribution of the demand, EO revenues have been generated primarily in North America (accounting for almost 50% of the value of sales), followed by Europe (above 20% including EU and non-EU countries). Focusing on the supply side of the market, North America leads, with Europe as a close second - this is based on maintaining the EO value chain differentiation of data acquisition and distribution, where North American companies lead with 50% of revenues, data processing, in which again North American suppliers dominate the market with around 55% of global sales, and analysis, insights & decision support.

The following provides an overview of the current market landscape and projections for space data:

Earth Observation (EO) Market

- Current Market Size (2024): Approximately $1.7 Billion (Commercial)
- Projected Growth:
    - By 2027: EO data market could reach $2.4 billion, with value-added services (VAS) potentially at $9 billion in optimistic scenarios.
    - By 2030: Combined EO data and services market expected to surpass $7.5 billion.
    - By 2033: Market projected to exceed $8 billion, driven by advancements in high-resolution imaging and increased demand across sectors like agriculture, environmental monitoring, and defence

Satellite Data Services Market

Market Size (2023): $130.4 billion

- Projected Growth:
    - By 2033: Expected to reach $248.3 billion, growing at a CAGR of 6.65%

Space Technology Market

- Market Size (2025): $512.55 billion

- Projected Growth:
    - By 2034: Anticipated to reach $978.13 billion, with a CAGR of 7.45%

Summary

Market Segment	2024/2025 Size	2030–2034 Projection	CAGR
Earth Observation (EO)	~$1.7B	$7.5B–$8B+	~4–6%
Satellite Data Services	$130.4B	$248.3B	6.65%
Space Technology (overall)	$512.55B	$978.13B	7.45%

Key Growth Drivers

- **Commercial Applications:** Expansion in sectors such as Fintech, Energy, Agriculture, Urban Planning, and Environmental Monitoring using EO data.
- **Technological Advancements:** Development of low-cost small satellites and enhanced data analytics capabilities.
- **Global Initiatives:** Growing investments in space infrastructure and policies promoting space commercialisation, especially in Asia and Europe.
- **Defence and Security:** Increased demand for high-resolution imagery and real-time data for surveillance and reconnaissance.

4. The Market for Space Data by Sector

4.1 Natural Capital

4.1.1 Market Definition

Natural Capital seeks to assign economic value to nature's assets and ecosystems, including forests, wetlands, soil, and subsurface resources such as minerals and fossil fuels. Whilst the following list is not exhaustive, it provides a summary of the main areas covered:

- Forests (which provide timber, oxygen, and carbon storage)
- Water resources (rivers, lakes, aquifers wetlands / paludiculture, and sometimes including coastal waters)
- Soil and land (for agriculture and habitat)
- Air quality
- Minerals and fossil fuels
- Ecosystems and biodiversity (pollination, flood control, climate regulation).

Agriculture and extracted minerals and fossil fuels are often separated out from Natural Capital as different industries, and this report follows that convention, with agriculture having its own section, and similarly fossil fuels being absorbed into the energy market, and minerals into the mining industry.

4.1.2 Market Landscape

The natural capital market landscape covers the areas noted in the market definition, and is very much still an emerging sector. Estimating the exact market value of natural capital

excluding agriculture and fisheries is challenging due to the intertwined nature of ecosystem services and the limited granularity of the available data.

4.1.3 Market Segmentation

From the space data perspective, Earth Observation data especially, supports the resources in the natural capital market being segmented as follows:

Forests
- Timber
- Non-timber forest products
- Carbon storage (Carbon credits)

Water Resources
- Freshwater for consumption/agriculture
- Water purification and hydrological services

Land
- Agriculture
- Paludiculture
- Natural habitats
- Soil carbon and health
- Estates
- Rewilding

Air and Atmosphere
- Carbon sequestration
- Air purification

Marine and Coastal Ecosystems
- Fisheries
- Coastal erosion
- Mangroves

Minerals and Fossil Fuels
- Non-renewable resources extracted for energy or industrial use

4.1.4 Market Applications - Forestry

Earth Observation space data is used for measuring the extent of forests in terms of areas, as well as delineating their borders to support the estimation of forest resources. These applications encompass commercial timber assessment, deforestation monitoring, and the utilisation of EO data in the context of OMRV (Observation, Monitoring, Reporting, and Verification) frameworks. At regional to global scales, EO systems are capable of capturing forest cover across hundreds of thousands to millions of hectares.

Observation constitutes the initial phase of this workflow, primarily focused on the acquisition of raw space data.

The monitoring component, enabled by the space based EO satellites, enables analysis of forest dynamics over time, which enables the impacts of external factors such as climate change to be checked. High-frequency and multi-spectral data streams allow for the detection of patterns in forest cover change, supporting environmental assessments.

The reporting phase involves the structured presentation of EO-derived metrics to inform compliance evaluations for ESG (Environmental, Social, and Governance). The outputs from these evaluations serve both regulatory oversight and the facilitation of sustainable finance mechanisms, such as carbon offset programmes.

Verification constitutes the final stage, wherein EO data is employed to corroborate reported metrics, ensuring the integrity and transparency of claims related to forest carbon stocks and land use changes.

Emerging methodologies integrating hyperspectral imaging and Light Detection and Ranging (LiDAR) for three-dimensional vegetation structure analysis are showing significant promise. While still in the developmental phase, these technologies are expected to provide high-fidelity characterisations of ecosystem structure and function. Researchers anticipate that such integrative approaches will significantly enhance the resolution and reliability of biodiversity and ecosystem monitoring, ultimately supporting more robust environmental management and policy decision-making frameworks.

4.1.5 Market Applications - Peatland

Peatlands represent a critical natural mechanism for carbon sequestration and long-term storage. Frequently underappreciated, these ecosystems constitute substantial carbon sinks, with extensive tracts present across Canada, the United Kingdom, and Northern Europe. Within the UK, peatland habitats have experienced progressive degradation over successive decades, primarily as a result of unsustainable land use and management practices. However, there is now growing recognition of the ecological and climatic significance of peatlands, prompting the implementation of targeted restoration initiatives.

The monitoring and assessment of peatland condition is an emerging and increasingly pertinent area within the environmental sector, offering potential for commercial development—particularly in relation to Earth Observation (EO) space data technologies. As carbon restoration efforts gain traction, there is an opportunity not only to advance Scottish space data capabilities within this area, but also to draw in inward investment to work in collaboration with international companies.

EO satellite data plays a vital role in supporting the validation and verification processes aligned with established carbon accounting standards, which then has synergy with industries such as Fintech. The integration of EO-derived metrics enables robust assurance of both the quality

and quantifiable impact of peatland carbon assets, thereby underpinning their credibility within carbon trading frameworks.

4.1.6 Market Applications - Wildfires

The increasing unpredictability of weather patterns associated with climate change has elevated the frequency, intensity, and spatial extent of wildfires. This presents a critical risk to forest ecosystems, with ramifications for biodiversity conservation, commercial timber production, and carbon accounting frameworks, particularly those linked to carbon offsetting and emissions trading schemes.

The use of Thermal infrared (TIR) space data, though traditionally a more specialised domain within commercial Earth Observation (EO), plays an essential role in the early detection and monitoring of wildfires. TIR sensors are capable of identifying thermal anomalies—such as elevated surface temperatures and active fire fronts—prior to detection via visible or near-infrared (VNIR) spectral bands, thereby enabling earlier intervention and more effective fire suppression strategies.

Recent advances in EO technology have seen the emergence of low Earth orbit (LEO) satellite constellations with dedicated thermal imaging capabilities. The proliferation of such platforms significantly enhances the spatial and temporal granularity of thermal datasets available for forestry applications. This enables continuous and scalable monitoring of fire-prone regions, supporting both tactical response operations and long-term forest management planning in the context of a changing climate.

From a Scottish context, given the forestry industry in Scotland, and the use of space data analysis of forestry in Scotland, there is an opportunity to draw in inward investment from larger countries such as the US or Canada with the argument that Scotland can not only support wildfire monitoring activity, but Scottish forests, being a fraction of the size of the US and Canadian forests provide a good training ground for applying space data to wildfire challenges.

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4.2 Agriculture and Agritech

4.2.1 Market Definition

The market for space data in agriculture and agritech in the context of this report, refers to the use of satellite-based space data, primarily PNT and Earth Observation (EO) space data, but also satellite communications (SatCom) and space enabled Internet of Things sensors. The space data in agriculture and agritech is used to enhance decision-making, optimise resource use, and support productivity and sustainability in agricultural systems.

4.2.2 Market Landscape

The market for space data in agriculture and agritech encompasses both traditional farming and high-tech agribusiness, as well as adjacent areas such as agricultural insurance, supply chain logistics, and food security monitoring.

4.2.3 Market Segmentation

Analysis of the agriculture use of space data within the space industry focuses on the space data providers and space data analysis and service providers. However, in the context of this inward investment report, the analysis has to progress from the opposite end of the spectrum, namely the end users. In this case, the market can be segmented as follows:

Food and Drink: Includes all agricultural products used in human food production and the drinks industry, from farm to supermarket to kitchen table.
Animal Feed: Agricultural products used for livestock feeding, such as grains and forage crops.
Biofuels: Agricultural products used to produce biofuels, such as corn (ethanol) and oilseeds (biodiesel).
Textiles: Agricultural products used in textile production, such as cotton and flax.
Pharmaceuticals and Cosmetics: Agricultural ingredients used in the production of medicines, essential oils, and cosmetics.

4.2.4 Market Applications – Regenerative Agriculture

In this application, the end user is a farmer or farm manager at the first level, but then the space data is also used for the next level which is the food aggregators, and it can even be extended to the food supply chain to supermarkets.

The combination of Earth Observation data use to provide multi-layered remote observation for spatial crop monitoring of soil moisture and water stress, and the use of PNT technologies through tractor mounted SatNav accurate to the centimetre level ensures crops can be cultivated with a high crop yield without causing environmental stress that would prevent regeneration of the land for future use.

The combination of using the new generation of small satellite constellations in Low Earth Orbits to provide Earth Observation space data for end users such as farmers on a tablet computer in the cab of their tractor, together with the PNT space data guiding their SatNav systems, demonstrates how these versatile new commercial solutions can monitor current crop yields, forecast future crop yields and ensure the quality of the land is maintained and regenerated.

4.2.5 Market Applications – Crop Insurance

As the climate becomes less predictable and more destructive (caused by droughts and floods), farmers have to adapt to this new reality. In this case, crop insurance can help farmers supplement their income when their fields don't get seeded. However, crop insurance fraud can be an issue of importance to insurance companies. As an example of this, insurance companies and the USGS have teamed up to investigate any wrongdoing, with the USGS measuring vegetation growth using space data from the Landsat Earth Observation satellite's red and infrared channels in combination with NDVI. Using this space data, crop insurance companies can verify seeded crops and catch fraud.

4.2.6 Market Applications - Precision Agritech

Precision agriculture is undergoing a transformation, driven by the integration of advanced technologies such as connected sensors, drones, and space data in the form of Earth Observation satellite imagery, PNT space data in the form of Global Navigation Satellite System (GNSS) positioning data and meteorological satellite information. Collectively these technologies use space data to enhance crop yields, optimise water resources, and enable greater sustainability in both arable and livestock farming.

In the UK and Europe, there is a greater use of Earth Observation and PNT space data in the form of GNSS data for Agriculture through using space data resources such as the European Union's Copernicus Programme. The Copernicus Programme provides invaluable insights into land use, vegetation health, and environmental conditions, and satellites used as part of the programme such as the Sentinel-3 satellite, provide high-resolution Earth Observation space data imagery to support the monitoring of crop development to a very high degree of precision. This information then enables farmers to make informed decisions regarding irrigation, fertilisation, and pest control, using very fine tuning of their operations in fields, thus enabling improved efficiency and reducing environmental impact.

4.2.7 Market Applications – Autonomous Agriculture

Major agricultural machinery manufacturers, such as John Deere, are developing autonomous tractors equipped with AI and computer vision systems. These machines use PNT space data to perform tasks like tillage and spraying with minimal human oversight, enhancing precision and reducing the potential for human error.

Companies such as FarmDroid have introduced solar-powered robotic platforms capable of precise seeding using PNT space data and mechanical weeding, offering sustainable alternatives to chemical herbicides.

4.2.8 Market Applications – Space Data for fertiliser decision making

To date, input providers selling seed, nutrients, pesticides, and equipment have played a critical role in the data ecosystem because of their close ties with farmers, their own knowledge of agronomy, and their track record of innovation. They are now engaging with the Earth Observation space data sector. For example, one of the world's largest fertiliser distributors now offers both fertilising agents and software that analyses field data to help farmers determine where to apply their fertilisers and in what quantity, and draws in Earth Observation space data to help make more robust decisions.

4.2.9 Market Applications – Weather Satellite Data for improving agricultural efficiencies

Weather satellite space data is used to support agricultural decision-making. By assimilating satellite imagery into Numerical Weather Prediction (NWP) models, the accuracy of forecasts can be enhanced/ This is essential for planning field activities, managing irrigation schedules, and anticipating weather-related risks. Improved forecasting helps farmers mitigate the impacts of adverse weather conditions, ensuring better crop resilience and yield stability.

4.3 Maritime and Aquatech

4.3.1 Market Definition

For this report, the maritime market refers to all sea-based economic activity covering the sea, oceans, and waterways, E.g., maritime shipping operations and fisheries. The aquatech market (short for "aquaculture technology") is a subset of the maritime market and refers specifically to technologies that support aquaculture—the farming of aquatic organisms such as fish, shellfish, and seaweed.

4.3.2 Market Landscape

Over 80% of global trade by volume and more than 70% by value is carried by sea (UNCTAD, 2023), with maritime shipping providing one of the most cost-efficient and carbon-efficient modes of large-scale freight transport. The maritime market also includes ports, and with large ports, these act as economic hubs, for instance in the UK, the London Gateway and in the Netherlands, the Port of Rotterdam, supporting land-based logistics, customs, warehousing, and jobs in synergy with the sea-based operations.

The blue economy, which includes fisheries as well as maritime shipping, has an estimated global value that is projected to be worth USD 3–5 trillion by 2030 (OECD) – much of it dependent on space data.

4.3.3 Market Segmentation

- Shipping and logistics (e.g., cargo shipping, freight transport, port operations)
- Marine engineering and shipbuilding
- Fisheries and marine resources
- Marine tourism and cruise operations
- Water quality monitoring and treatment
- Fish health and welfare technologies (e.g., sensors, diagnostics, vaccines)
- Data analytics and IoT for aquaculture
- Sustainable sea farming practices (e.g., reducing waste, improving efficiency)

4.3.4 Market Applications – Littoral and inshore zones

The marine environment is under-sampled compared to the land environment, meaning that there is less data available for analysis, but plenty of opportunity, covering areas such as; marine data for seagrasses, kelp forests, sandy coastlines and salt marshes, mangroves, warm and cold-water coral reefs and monitoring of coastal erosion and pollution. Given the larger area of coverage and rapid temporal revisit capability of Earth Observation satellites, the use of space data has become more of interest compared to the traditional use of ships for data acquisition and measurement. These capabilities also provide another benefit for Earth Observation space data use for enforcing marine regulatory and sustainability compliance.

4.3.5 Market Applications – Fisheries and Aquaculture

Space data is used to support fisheries through the use of Earth Observation space data to detect plankton, which provides an indication of where large shoals of fish are likely to congregate. The ability to observe fishing activities from space, combined with space data-based communications, plays an important role in the management of fisheries and fishing activities. The combination of two fundamental factors—knowing the marine environment and knowing where fishing takes place, both of which are augmented by space data, provides a powerful and productive approach to achieving more productive, better managed and more sustainable fisheries.

4.3.6 Market Applications – Sea Surface measurement

Earth Observation space data does not only include imaging sensors however, but also includes point sensors such as LIDAR. Satellite based LIDAR is becoming increasingly useful

for protecting the coastal environment, and in conjunction with aerial data, can be used to measure coastal stability and mitigate potential land collapse caused by coastal erosion. More recently, space data used for sea surface measurement has been demonstrated to be of considerable value to locating offshore wind turbines in large North Sea wind farms.

4.4 Fintech

4.4.1 Market Definition

Fintech is the integration of technology into financial services to improve financial service company's products for use by consumers and businesses. Fintech encompasses a wide range of market segments including banking, payments, investment and insurance.

4.4.2 Market Landscape

Space data is increasingly being integrated with fintech (financial technology) to enhance decision-making, improve financial services, and drive innovation. The use of satellite data in the fintech sector leverages Earth Observation, geospatial analysis, and other space-derived information to provide insights into a wide range of financial applications.

Space data is thus playing a role in the transformation of the fintech sector by improving risk analysis, enhancing decision-making processes, fostering sustainability, and enabling financial services in previously inaccessible or underdeveloped regions. Through satellite data, fintech

companies gain valuable insights into markets, environmental factors, and operational risks, leading to more informed, efficient, and transparent financial services.

The recent introduction of the EY FinTech Lab in both Edinburgh and London promises to be a dynamic hub globally connecting Fintech experts from over 800 firms with new and existing businesses seeking to improve their business models [4]. Building on the UK's remarkable Fintech success narrative, the EY FinTech Lab serves as a catalyst for innovation acceleration, enabling rapid market entry and amplified growth trajectories. Through strategic and operational support, EY FinTech Lab fosters collaborations that drive impactful change, meeting evolving consumer demands.

4.4.3 Market Segmentation

Whilst the market applications indicated in this section are varied, we have assumed segmentation according to Financial technologies, insurance reinsurance, commodities and cryptocurrency, because of the space related solutions that have resulted from these market segments.

4.4.4 Market Applications – Agriculture and Supply Chain Financing

- Crop Monitoring & Yield Prediction: Satellites collect data on crop health, soil moisture, and environmental conditions, which is then used by fintech companies to predict crop yields and assess the risk associated with agricultural loans or insurance. Space data allows for better decision-making in agricultural finance, enabling lenders to offer more accurate loan terms based on predicted yield outputs and risk assessments.

- Supply Chain Management: Space data helps track the movement of goods, raw materials, and products, providing real-time information to banks, insurers, and financiers involved in trade financing, logistics, and supply chain management. By leveraging this information, fintech companies can streamline trade finance operations and assess the financial risks associated with different supply chain stages.

4.4.5 Market Applications – Risk Assessment and Credit Scoring

- Geospatial Risk Analytics: Satellite imagery can be used to assess environmental, weather, and geographical risks, such as flood zones, droughts, and natural disasters. This data helps fintech companies evaluate the risk profiles of individuals, businesses, and regions when providing loans, mortgages, or credit. By incorporating space-based risk data into credit scoring models, fintech firms can create more accurate and dynamic lending decisions.

- Land and Estate Valuation: Space data enables accurate monitoring of land use, urban growth, and infrastructure development. This geospatial information can be used to determine the value of properties, especially in remote or developing areas, allowing fintech firms to offer real-time property valuation services. Satellite data is also useful in assessing

the environmental risks (e.g., flood risk) that could affect property value, thereby enhancing lending models.

4.4.6 Market Applications – Insurance and Reinsurance

- Disaster Management and Loss Assessment: Satellites can provide real-time imagery and data on natural disasters such as floods, hurricanes, or wildfires, enabling insurance and reinsurance companies to assess the extent of damage more efficiently. This improves claims processing, risk modelling, and overall policy pricing. Fintech solutions in the insurance space leverage satellite data to create better models for risk underwriting, enabling insurers to offer more competitive products based on satellite insights.

- Climate and Weather-Related Insurance: Space data, including weather satellite feeds, allows fintech firms to develop tailored insurance products for climate-sensitive sectors. For instance, agricultural insurance policies can be underwritten based on satellite-based crop health monitoring and climate forecasts, reducing risk for both insurers and policyholders. Higher insurance premiums can be more fairly calculated in flood-prone areas using GIS and remote sensing applications that use satellite-based radar and hydrological modelling, to map out areas more prone to flooding, to measure how often these areas would flood, and how serious the damage could be. In turn, this helps the insurers to better assess risk.

4.4.7 Market Applications – Fraud Detection and Compliance

- Geospatial Analytics for Fraud Prevention: By analysing space data in combination with other financial data, fintech firms can detect anomalies in transactions, particularly in sectors such as e-commerce, real estate, and cross-border trade. Satellite imagery can be used to confirm physical assets' location and assess whether transactions are taking place in line with reported geographies. This helps in preventing fraudulent claims or activities.

- Compliance: Space data can enhance KYC (Know Your Customer) and AML (Anti-Money Laundering) procedures by offering geospatial insights into the legitimacy of business addresses, physical locations, and land ownership, ensuring that financial transactions are in line with regulatory frameworks. This is particularly useful in regions where verifying identity or business operations is challenging.

4.4.8 Market Applications – Sustainability and Green Finance

- Carbon Footprint Measurement: Space-based sensors can measure the carbon emissions of industries and track environmental footprints on a large scale. Fintech companies involved in green finance and carbon trading can use satellite data to track emissions and monitor compliance with sustainability regulations. This helps to ensure that carbon credits or sustainability-linked bonds are correctly issued and tracked.

- Environmental, Social, and Governance (ESG) Monitoring: Satellite data can provide objective, real-time data on the environmental impact of corporations and industries, assisting fintech platforms in monitoring ESG metrics. By integrating space data, fintech firms can offer investors and institutions more accurate ESG ratings and indices for sustainable investment.

4.4.9 Market Applications – Asset Management and Investment

- Market Intelligence and Trend Analysis: Satellite data provides insights into market trends, especially in agriculture, infrastructure, and real estate, by tracking land use, resource availability, and urban development. Fintech platforms offering asset management services can incorporate this information to predict market movements and assist investors in making informed decisions based on satellite-derived data.

- Geospatially-Enhanced Financial Products: Fintech companies can leverage satellite data to create geospatially enhanced financial products, such as location-based investment opportunities, land-backed securities, or development bonds tied to specific geographic areas. These products benefit from a detailed and real-time understanding of the environmental and economic conditions of the targeted regions. As an example of this, companies use satellite imagery to count the number of vehicles in car parks at superstores and out of town retail locations. In turn, this gives a snapshot of earnings, conversion rates, and market share. All things considered, it's a simple high-tech strategy that can give market analysts the information needed.

4.4.10 Market Applications – Cryptocurrency & Blockchain Applications

- Satellite-Based Blockchain Networks: Space technology is being integrated with blockchain, especially in the context of satellite networks that enable secure, global communication. Certain blockchain platforms use satellite technology to provide decentralised, satellite-based networks for transmitting cryptocurrency transactions. Space-based solutions enable more secure and scalable blockchain networks, particularly in remote regions with limited internet access.

- Mining and Energy Monitoring: Space data can be used to monitor environmental and energy resources used in cryptocurrency mining operations. By assessing land use, energy consumption, and environmental impact, fintech companies involved in cryptocurrency can better track the sustainability of mining operations and their environmental footprint.

4.5 Energy and Utilities

4.5.1 Market Definition

The market for space data in the energy and utilities sectors refers to the commercial, operational, and regulatory use of satellite-derived space data; PNT space data, Earth Observation (EO) space data and to a lesser extent, satellite communications (SatCom) data, to support the generation, distribution, monitoring, and management of energy and utility services. This includes the use of space data in the context of traditional hydrocarbon energy sources such as oil, gas, and coal, as well as renewable energies including solar, wind, nuclear, hydroelectric, and geothermal.

The market is driven by increasing digitalisation, the decentralisation of energy systems with a move towards distributed energy generation, the need for climate resilience and energy security, and regulatory pressures to adopt sustainable and intelligent infrastructure.

4.5.2 Market Landscape

The market landscape for space data use in the energy and utilities markets includes, geospatial analytics providers, energy generation companies, energy distribution and infrastructure companies, public sector watchdogs, and can even be considered to include

satellite operators and space data providers, where they specialise in these markets. As with other market sectors, there is an increasing use of Earth Observation (EO) space data with AI, machine learning, big data and cloud platforms. Additionally, regulatory shifts toward environmental accountability, decarbonisation, and infrastructure resilience are creating strong incentives for the integration of space data derived insights and intelligence into strategic planning and operational workflows.

4.5.3 Market Segmentation

The space data market within the energy and utilities domain can be segmented in a number of ways. In the context of this report, the market is segmented as follows:

1. By Energy Type:
    - *Fossil fuels*: Earth Observation (EO) space data supports exploration, pipeline monitoring, and environmental compliance.
    - *Renewables*: Earth Observation (EO) data is used for solar irradiance mapping, wind resource assessment, and hydrological modelling.
2. By Utility Service:
    - *Electricity*: Grid monitoring, outage detection, and load forecasting, using space communications data and predictive forecasting using space weather data forecasts from Solar monitoring satellites.
    - *Water*: Watershed management, leak detection, flooding and drought planning, using Earth Observation (EO) and PNT space data.
    - *Gas*: Pipeline monitoring, leak detection, and infrastructure siting, using Earth Observation (EO) and PNT space data.
3. By Function:
    - *Environmental monitoring*: Earth Observation (EO) space data to monitor and track emissions, vegetation encroachment on infrastructure, and use of weather satellite data for weather risk monitoring and analysis.
    - *Disaster response*: Earth Observation (EO) space data use to monitor energy and utilities services post-floods, fires, or storms.

4.5.4 Market Applications - Renewable Energy Siting and Forecasting

Earth Observation (EO) space data is used to assess solar irradiance for solar power stations, wind patterns for wind power stations, water supply and local hydrology for cooling of nuclear power stations, and hydrological cycles for hydroelectric and microhydro power stations, to optimise the siting and performance of renewable installations.

4.5.5 Market Applications - Infrastructure Monitoring:

Earth Observation (EO) space data (including SAR data in the case of subsidence), is used to support the detection of land subsidence, the threat of vegetation encroachment on

infrastructure, and structural anomalies in transmission lines, pipelines, and power plants. It can even be used for leak detection from changes in flora types and concentration in the vicinity of a leak.

4.5.6 Market Applications - Environmental and Regulatory Compliance:

Earth Observation (EO) space data can play an important role in the energy and utilities markets by assisting with emissions monitoring using specialised point sensors to detect gas emissions and imaging sensors to detect and monitor, land use change detection, as well as helping enable impact assessments, and helping operators comply with environmental regulations and meeting ESG requirements.

4.5.7 Market Applications - Disaster Preparedness and Response:

Earth Observation (EO) space data can provide near real-time, and even real-time data on wildfires, floods, and extreme weather events, enabling rapid response and restoration of critical energy and utilities services following disasters. Additionally, PNT space data can help support the accurate location of relief energy and utility services.

4.5.8 Market Applications - Energy Market Intelligence:

Earth Observation (EO) space data e.g., Thermal Infra-red imagery of power plants, traffic at ports, or storage tank levels — is used in commodities trading and supply-demand modelling, thus providing a segue into the Fintech and Financial markets.

4.6 Transport and Logistics

4.6.1 Market Definition

Transport and Logistics can be defined as the systems, services, and infrastructure used to move goods and people efficiently from one location to another, and to manage the flow of materials across the supply chain.

Transport is the physical movement of goods or people from one place to another via road, rail, air, sea, or pipeline.

Logistics is the process of planning, implementing, and controlling the efficient flow and storage of goods, services, and information from origin to consumption.

Transport is a subset of logistics. Logistics encompasses the broader strategy, coordination, and systems behind transportation.

4.6.2 Market Landscape

The transport aspect of the transport and logistics market from a space data end user perspective can be broken down into:

Road: Lorries, vans, cars (used for passenger transport or as delivery vehicles)
Rail: Freight and passenger trains
Sea: Shipping vessels, cargo ships
Air: Cargo aircraft, commercial passenger aircraft

4.6.3 Market Segmentation

From an end user of space data perspective, the market landscape for transport and logistics can be separated into the following segments:

- Navigation & Positioning (GNSS/GPS)
- Earth Observation (EO)
- Satellite Communication (Satcom)
- Weather Forecasting & Hazard Monitoring
- Supply Chain Visibility & Security

4.6.4 Market Applications - Real-time fleet management and route optimisation.

Real-time fleet management and route optimisation using Navigation & Positioning (GNSS) space data to enable precise vehicle tracking for trucks, ships, aircraft, and trains. The use of space data in this context can even be extended to autonomous vehicles, drones, and robotics in warehouses.

The well-known examples of logistics companies such as DHL and UPS use GPS not only to guide their drivers to their destinations, but also to monitor delivery vehicle locations to ensure customers are updated of delivery times, as well as to optimise routes to reduce delivery times, reduce fuel use and reduce operational costs. This seamless use of space data goes unnoticed; however, it also plays a role in improved safety and compliance and greater supply chain transparency through the ability to use the tracking data.

Within Scotland, companies such as SEKO logistics are already leveraging the space data aspect of their logistics operations for providing carbon emissions certification.

4.6.5 Market Applications - Port and terminal monitoring via space data

Port and terminal monitoring enables more efficient transport and logistics operations in a similar way to delivery services detailed in fleet management and route optimisation in the previous market application. Port and terminal monitoring is achieved through the use of Earth Observation space data for visual monitoring and PNT space data in the form of GNSS data for precise movement and placement.

4.6.6 Market Applications - Detect physical changes to land monitoring via Earth Observation space data

The use of space data to detect physical changes to land such as landslides, vegetation growth or flood-damaged infrastructure is of increasing importance and usefulness for maintaining the integrity of road and rail infrastructure. Synthetic Aperture Radar space data can be used to monitor the integrity of a waterlogged slope, and the space data can then be analysed to determine the level of risk to adjacent transport infrastructure.

Vegetation growth is an increasing issue for infrastructure such as rail, since with increased CO2 in the atmosphere, vegetation grows faster and more vigorously, and needs more frequent monitoring. Earth Observation space data provides a cost-effective means of monitoring vegetation growth to ensure timely addressing of potentially damaging foliage.

Whilst flood damage is often visually obvious, the extent of the flood damage is often better viewed from a higher vantage point, and whilst drones are playing an increasingly important role, their navigation is achieved via the use of PNT space data. When this is combined with the orbital repeatability of Low Earth Orbit satellite constellations, flood damage can be imaged rapidly, and the space data delivered to road and rail transport networks and management systems.

4.6.7 Market Applications - Assess and plan logistics hubs monitoring via Earth Observation space data

Infrastructure plays a key role in transport and logistics, since products need to be stored before onward transit. Optimising the location of logistics hubs can now be achieved through using space data to assess and plan logistics hubs locations such as warehouse site selection using Earth Observation space data and then ongoing monitoring via a combination of Earth Observation and PNT space data.

4.6.8 Market Applications - Satellite Communication (Satcom)

Satellite communications provides connectivity in remote areas where terrestrial networks are unavailable (e.g., maritime or rural logistics routes). For mobile applications, satcom has become an essential resource for real-time updates from cargo ships, aircraft, and off-grid supply chains. As an example, ships on transoceanic routes use satellite communications to share location and cargo data continuously.

4.6.9 Market Applications - Weather Forecasting & Hazard Monitoring

Space-based meteorological data helps in the prediction and avoidance of extreme weather through alternative routing, reducing the risk of delays and cargo damage. An additional aspect is that space data from meteorological satellites supports resilient logistics planning during

disasters. A classic example is airlines and shipping companies rerouting assets to avoid storms using satellite-derived forecasts.

4.6.10 Market Applications - Supply Chain Visibility & Security

Another use of space data in the transport and logistics industry is through the use of Earth Observation satellite imagery to verify cargo movement, monitor border crossings, and detect illegal shipments or delays. Space data can be fed into customs tracking systems and global logistics platforms.

An increasing use of space data in this application is for space data enabled IoT sensors for asset tracking (e.g., containers, trailers). The increasing miniaturisation of technology has led to IoT tracking sensors using narrowband communications and PNT space data, that are less than 2 centimetres in length, width and height.

4.6.11 Market Applications - Inventorying and assessing rural road conditions with space data and UAVs

With the integration of Earth Observation and GIS, unmanned aerial vehicles working in conjunction with the space data, are providing answers on pothole detection, road surface analysis, and road conditions for unpaved roads.

Using Geospatial Positioning space data with centimetre accuracy, rural road conditions can be assessed and inventoried saving time and money. This approach not only streamlines maintenance efforts but also contributes to safer and more efficient rural transportation networks, benefiting both communities and infrastructure management.

4.7 Mining

4.7.1 Market Definition

In the context of this report, the market for space data in the mining industry refers to the use of primarily PNT data, Earth Observation (EO) data and satellite communications (SatCom), to support the exploration, planning, operation, and monitoring of mining / extractive activities of all forms. The space data for mining market encompasses the acquisition, processing, analysis, and distribution of geospatial data that enhances operational efficiency, reduces the environmental impact, and ensures compliance with regulatory frameworks - the latter two points being key to help meet ESG goals and minimise unsustainable operations.

4.7.2 Market Landscape

The competitive landscape of the space data for mining market is characterised by a mixture of established satellite data providers (e.g., Airbus, Maxar, Planet), specialist geospatial analytics firms, and emerging start-ups focused on space-based solutions for resource management. Partnerships between mining companies and technology providers are becoming more widespread, reflecting a trend towards digitalisation in extractive industries. The landscape is further shaped by regulatory frameworks governing environmental sustainability and land use, which are driving demand for Earth Observation (EO) data for Observation, Monitoring, Reporting and Verification (OMRV) to demonstrate ESG compliance and support corporate social responsibility objectives.

4.7.3 Market Segmentation

The space data for mining market can be segmented by **function**; namely the mining equivalent of upstream and downstream, namely upstream, which is characterised by exploration, site assessment and development, and downstream, which is characterised by operational monitoring, logistics, environmental compliance and post-mining land rehabilitation stages of mining, and is increasingly driven by the integration of remote sensing, artificial intelligence, and data analytics into traditional mining operations.

The space data market for mining can also be more readily segmented by **data type,** than some of the other non space markets referred to in Section 4. This is because the use of space data for the mining market makes use of a wide range of sensor technologies in Earth Observation, as well as PNT data using GNSS and RTK to provide high quality geospatial insights. Segmentation by data type includes GNSS data augmented by RTK enabled data, high-resolution optical data, multispectral and hyperspectral imagery, synthetic aperture radar (SAR), and thermal Infra-Red imaging.

4.7.4 Market Applications - Space data and geological / mineral exploration

In the **geological exploration phase**, Earth Observation space data can be used to identify promising geological / geomorphological land formations, reducing the need for costly ground-based surveys, sometimes into hostile, life-threatening or contested environments. This space data can even be at the broad, lower resolution scale initially, using data from satellites such as Landsat, which cover a wide area at lower resolution, with higher resolution, more expensive space data from companies such as Maxar and Planet being used once the areas are identified.

4.7.5 Market Applications - Space data and mining operations and monitoring

During operational phases, Earth Observation space data is used for monitoring open-pit mines, tailings dams, water usage, and land deformation, often in near real-time. High resolution optical, multispectral and hyperspectral imagery can be used for monitoring tailings dams. Additionally, Synthetic Aperture Radar (SAR) space data, can be used to enable the detection of ground subsidence and early warnings of geotechnical instability, which can then be monitored further by deploying space data enabled IoT sensors on the ground, once an issue is identified.

4.7.6 Market Applications - Space data and mining environmental monitoring and sustainability

In the context of environmental monitoring of mining operations, Earth Observation space data is used to assist in measuring air quality, vegetation health, and water contamination, which are vital for meeting regulatory and sustainability targets for ESG, as well as helping to determine Carbon emissions.

4.7.7 Market Applications - Space data and post-mining land rehabilitation.

Finally, in post-mining land rehabilitation, Earth Observation space data supports efforts to restore ecosystems and track the recovery of affected land over time, informing both companies as the stakeholders and policymakers for determining future mitigation and rehabilitation strategies.

4.8 Health & Wellness

4.8.1 Market Definition

Whilst not traditionally associated with healthcare, space data — particularly PNT derived space data and Earth Observation derived space data — enables the tracking and / or monitoring of air quality, UV radiation levels, detection of diseases such as malaria and dengue and other global health challenges. The same space data is also used for individual wellness and consumer health tracking, along with the growing capabilities associated with remote healthcare and telehealth. As a result of this, the health sector is beginning to recognise the value of integrating satellite data into epidemiological models and early-warning systems.

4.8.2 Market Landscape

The market landscape for space data in the health and wellness sectors is actually enormous in terms of the individual wellness segment of the market, when one considers the amount of people with smartphones and fitness trackers, relying on GNSS signals which are essentially PNT space data. From an environmental health monitoring perspective, as well as telehealth and remote monitoring, the use of space data is at a much less mature, early stage of use, with initiatives tending to favour public sector initiatives such as smart cities and health monitoring at a wider, but less individual scale for urban use, and at a much more limited scale for telehealth and remote monitoring, even though the opportunity space is both large, and would benefit the public good significantly.

4.8.3 Market Segmentation

For the health and wellness markets, the segmentation in the context of this report is laid out as:

Environmental health monitoring, where space-based Earth observation (EO) data is leveraged to track pollution levels, monitor climate-related health risks, and assess exposure to harmful UV radiation or airborne particulates. This segment serves both public health authorities and environmental agencies by providing large-scale, real-time data to support surveillance, risk modelling, and policy intervention.

Individual wellness and consumer health technologies, where satellite data is integrated into applications targeting the general population. This includes mobile wellness platforms, fitness trackers, and personalised health apps that use environmental insights—such as pollen counts, air quality indices, and heat exposure forecasts—to tailor lifestyle and exercise recommendations. This consumer-facing segment is increasingly aligned with trends in preventive health and digital wellness, appealing particularly to health-conscious individuals in urban environments. Technology firms in this space are beginning to collaborate with EO

data providers, whilst using PNT data in the background, to enhance the accuracy and contextual relevance of their health-related services.

Telehealth and Remote Health Monitoring, where satellite data from Satellite Communications (SatCom) is added to the more widely used PNT and Earth Observation space data used in many applications to produce TeleHealth. The integration of space data into remote telehealth and social care systems represents a transformative development in the delivery of health services, particularly for geographically isolated or underserved populations. The application of space data in remote care aligns with broader policy objectives concerning digital health coverage and sustainable healthcare delivery.

4.8.4 Market Applications – Remote Health Monitoring

National health systems and international development agencies are increasingly investing in space-enabled health innovations as part of long-term strategies to decentralise care, reduce hospital admissions, and improve outcomes in hard-to-reach communities. Moreover, as artificial intelligence and geospatial analytics mature, the fusion of space data with clinical level decision-support tools presents new opportunities for predictive care models now being trialled. Thus, the role of space data in supporting telehealth and social care services is likely to expand, offering a resilient framework for addressing healthcare geographical disparities in the digital age.

4.8.5 Market Applications – Telehealth

Satellite communications (SatCom) play a crucial role in enabling remote consultations, diagnostics, and monitoring by providing connectivity in areas where terrestrial infrastructure is limited or non-existent. This is particularly relevant in rural regions, offshore communities, and disaster-stricken zones, where consistent internet access cannot be guaranteed. By facilitating the real-time exchange of clinical information and video links between patients and healthcare providers, satellite-enabled telehealth solutions help bridge critical gaps in access to care.

4.8.6 Market Applications – Space data and air pollution

Commercial opportunities for using space data (PNT and Earth Observation data), have been established for a considerable time at the intersection of space data and the wellness industry. Environmental intelligence derived from PNT and Earth Observation data is increasingly being embedded into consumer-facing wellness platforms and mobile applications. For example, real-time air pollution data from satellites can inform individual decisions about outdoor exercise, particularly for those with respiratory conditions.

4.8.7 Market Applications – Space data and allergies

Similarly, space-based insights into environmental stressors—such as extreme heat or pollen levels—can be linked to wearable technology such as smart watches, either directly, or through connections with smart phones, offering personalised wellness recommendations. Companies in the digital health and fitness space are beginning to explore these integrations as part of broader trends toward data-driven and preventive health strategies.

4.9 Construction

4.9.1 Market Definition

The construction market has traditionally depended on manual surveying and on-site assessments. The advent of space data as well as drone technology, the Internet of Things and other advanced technologies has provided new opportunities to enhance planning, efficiency, and sustainability. Space-derived data, particularly PNT data and Earth observation satellite data, has emerged as a key asset in this regard. PNT satellite data in the form of GNSS and RTK data provides, in some cases, sub-centimetre levels of accuracy and precision. High-resolution imagery, multispectral and hyperspectral data, and synthetic aperture radar (SAR) offer construction professionals unparalleled insights into terrain conditions, land use, and environmental changes. The integration of such data into digital construction workflows facilitates more informed site selection, risk assessment, and project planning, particularly in terms of large-scale infrastructure and urban development projects.

4.9.2 Market Landscape

From a commercial perspective, the market for space data in construction is being driven by growing demand for geospatial intelligence and the digital transformation of the built environment. Satellite data feeds directly into geographic information systems (GIS), building

information modelling (BIM), and predictive analytics platforms, enabling real-time monitoring of construction sites and the surrounding environment. This is particularly valuable for monitoring progress, detecting structural anomalies, assessing the impact of weather conditions, and ensuring compliance with environmental and regulatory standards. Companies providing space data analytics services, as well as IT firms specialising in geospatial software, are increasingly targeting the construction industry with tailored solutions that combine satellite imagery with AI and cloud computing. It should be noted however, that the opportunity space for this market is still huge, since the potential still has a long way to be tapped.

4.9.3 Market Segmentation

In terms of market segmentation regarding the use of space data in construction, there is still a significant public sector aspect to the market, with alignment with policy priorities related to smart cities, climate resilience, and sustainable development.

Public-sector support, including open access to satellite datasets from Earth Observation space data programmes such as the European Copernicus and US Landsat, has helped reduce barriers to entry and fostered innovation within the sector. In the UK and internationally, collaborations between space agencies, research institutions, and construction firms are advancing the development of tools and standards that support the operational integration of space data. As such, the construction sector represents a growing and strategically significant market for space data, with ongoing opportunities for both commercial expansion and technological innovation, or, to provide a more direct precis, to repeat the comments in the Market Landscape section, the opportunity space for this market is still huge, since the potential still has a long way to be tapped.

4.9.4 Market Applications – Evaluation of Potential Construction Sites

Earth Observation space data and PNT space data can support the early-stage evaluation of potential construction sites by providing up-to-date data on topography, land use, vegetation cover, flood risk, and proximity to protected or regulated areas. High-resolution Earth Observation space data enables rapid environmental screening and feasibility assessments, reducing the need for costly and time-consuming ground surveys.

4.9.5 Market Applications – Smart Cities and Urban Planning

Earth Observation space data and PNT space data can be used to support smart city planning by mapping land use, infrastructure density, transportation flows, and green space distribution. The space data can additionally help planners and architects design more liveable, efficient, and sustainable urban environments, particularly when combined with socio-economic and sensor-based data sources.

4.9.5 Market Applications – Construction Monitoring

Time-series space data provides a high-level view of construction progress, enabling stakeholders to verify timelines, track changes, and document milestones. This application is particularly valuable for projects in remote areas or across large footprints. It also allows investors, insurers, and public authorities to monitor compliance and performance without needing frequent site visits.

4.10 IT

4.10.1 Market Definition

The IT market in the context of space data broadly encompasses the development, processing, analysis, distribution, and commercialisation of data collected from satellites and spacecraft. This can be any of the space data described in this report.

As a distinction from the more specialised nature of space data analysis which falls under the purview of the space industry per se, the IT industry plays a pivotal role in the background, seamlessly ensuring the efficient handling, storage, and transmission of data and vast datasets, often in partnership with cloud service providers, data analytics platforms, and AI-driven decision-making tools.

In this context, the IT market can be defined as enabling the transformation of raw satellite imagery and telemetry into actionable insights through sophisticated data processing algorithms, machine learning models, and visualisation tools. Additionally, the development of interoperable data infrastructures and standardised APIs as is widely used in the IT sector, facilitates wider access to and integration of space-derived data into everyday commercial and governmental operations. This has enabled IT companies to become more integral to value creation in the space economy, with IT concepts such as software-as-a-service (SaaS) platforms now becoming more widespread in the IT and space data markets.

4.10.2 Market Landscape

The market landscape for IT in terms of space data has grown significantly in recent years, driven by advances in Earth Observation technologies with sensors with much higher resolutions operating across many wavelengths (essentially equivalent to having the data from thousands of photos overlaid on top of each other), the proliferation of small satellite constellations, and an increasing demand for real-time, high-resolution satellite data coupled with PNT / geospatial data across multiple domains.

Cybersecurity has become a much more integral part of the IT sector with regard to space data, as the space industry has become aware of how vulnerable space data is to being compromised. Whilst already playing an important role within the space sector, the role of Cybersecurity in the context of space data is poised to become even more important, as the Fintech industry develops space-based applications, and requires robust data security.

4.10.3 Market Segmentation

Commercial applications of space data were initially in defence and meteorology. In the last few decades, these applications have expanded to sectors such as agriculture, urban planning, environmental monitoring, disaster response, and logistics - hence all the applications listed in Section 4.

4.10.4 Market Applications - Cybersecurity

There is an inherent challenge within satellite technology stemming from the fixed nature of hardware post-launch. Early detection and the mitigation of cyber threats coupled with the extended operational life, rapid technological advancements but fixed nature of unalterable space hardware pose a cybersecurity risk.

There is also a need for preventative initiatives. For example, space data disruptions carry hefty economic costs; a 24-hour GNSS outage could cost the UK £1.4 billion, rising to £7.6 billion for a week-long disruption, and Solar Activity on the scale of the Carrington Event could be catastrophic for space-based assets. This underscores the crucial importance of robust cybersecurity measures. The recent energy disruption in Spain and Portugal, whilst caused by energy infrastructure challenges rather than space data disruptions, demonstrates the havoc that adverse space weather could cause, and the need to consider the importance of cybersecurity in this context.

Protocols to provide end to end secure, encrypted machine to machine space data communications between satellites and ground or drone are being developed. Airbus Defence and Space developed solutions such as the Orion Malware, CyberRange and EctoCryp solutions with the capabilities to provide advanced analytical and simulation tools for this purpose.

4.10.5 Market Applications – Quantum Security

Space based Quantum Key Distribution (QKD) provides a secure method for key distribution, especially when combined with space to ground / ground to space optical communications. QKD has benefits for major industries which use quantum cryptography to manage highly sensitive data systems, including financial transactions, telecommunications, energy, healthcare and military communications. The Amplified Quantum Key Distribution (AQKD), funded by Innovate UK has assessed the technical and commercial feasibility of using CubeSats resulting in numerous follow up projects to align the use of CubeSats complimentary to ground-based networks or larger satellite constellations.

QKDSat is an ESA Partnership Project to provide secure quantum cryptographic key delivery services from orbit to terrestrial clients, for a range of applications covering commercial and government sectors where secure communication of information is critical. As well as enhancing Europe's cyber security capabilities considerably, ESA turned to UK quantum key distribution services company, ArQit to develop QKDSat. ArQit provides UK leadership to a team that includes: QinetiQ; BT, Teledyne e2v as well as key players in Germany, Austria, Canada, the Czech Republic and Switzerland.

5. The Market for Space Data by Geographical Area

The geographies identified were those for which there is known usage of space data in non space-related industries.

- US & Canada
- Europe
- MEA
- East Asia
- Australia

For the geographical analysis, in order to map the key geographies by sector for alignment with Scotland's strengths and high inward investment potential, the statistics for each geography was evaluated and tabulated in terms of GDP share per industry sector.

This provided a baseline from which sectors could be evaluated in terms of which were most like to use space data or have potential for space data usage, which could then be mapped against Scotland's strengths and for the high inward investment potential. Previous analysis has used data from sources such as the EUSPA (European Union Agency for the Space Programme) annual reports, which have global coverage, however, this would have restricted the opportunity space that exists for space data in the wider global marketplace.

5.1 USA

For the US, the financial sector has the largest share of GDP. Whilst often perceived as banking and the financial markets, finance is in reality a very broad grouping, covering insurance, property financial activities and valuation of property and land, as well as financial products such as Carbon credits. The range of applications for space data in the Fintech sector has been highlighted in Section 4, and given the share of GDP in the US, the Fintech / Financial sector should be considered with regard to space data engagement.

Agriculture has a smaller share of the GDP than the sectors indicated in the table, however this does not take into account food and drinks aggregation and processing, which is incorporated into the fourth ranked manufacturing sector, retail of food and drink which is incorporated into the third ranked sector, wholesale and retail trade, and the distribution of food and drink, which is incorporated into both of these sectors. Given the key role the sector plays across a wide range of sectors in terms of feeding the nation, and given the opportunity for expanding the use of space data and engaging with the US based very large food aggregator multinationals, this is another sector that should be engaged regarding space data opportunities.

The US government sector is excluded from the table because it is a consumer rather than generator of revenue, however it should not be excluded from the opportunity space, because within this sector is spending on areas such as federal infrastructure and defence.

The fourth ranked, manufacturing sector, covers a huge range of sectors within its grouping as part of GDP, of which, aerospace and automobiles have the most relevant use of space data. It should be noted that transport and logistics also acts as a lubricant for all the sectors ranked in the table, and as a sector that uses space data, there are synergies with this sector too.

RANK	SECTOR	APPROX SHARE OF GDP	DETAILS
	Finance, Insurance, Real Estate, Rental & Leasing	~21%	Includes banking, insurance, housing, and commercial real estate
2.	Professional and Business Services	~13%	Legal, consulting, R&D, accounting, advertising, and tech services
3.	Wholesale and Retail Trade	~11%	Retail chains, e-commerce, B2B sales
4.	Manufacturing	~10%	chemicals, pharmaceuticals, electronics, aerospace, automobiles
5.	Healthcare and Social Assistance	~9%	Hospitals, clinics, elder care, insurance-related healthcare administration

Note 1: 2023–2024 figures from the U.S. Bureau of Economic Analysis
Note 2: The US government sector is ~12% of GDP, however for this analysis, commercially derived figures are used.

5.2 Canada

The categories are ranked slightly differently in terms of their GDP share of Canada, this is an outcome of the national statistics body for Canada using a different separation of sectors, thus Real Estate and Rental and leasing is considered separately to Finance and Insurance, whereas in the US, they are combined. If these sectors are combined for Canada for a direct comparison with the USA, the approximate share of GDP is ~20-21%, or the same share of GDP in both countries.

Mining, quarrying and oil and gas extraction have a greater share of GDP than in the US or Europe, although the manufacturing share of GDP in Canada is similar to the US. It should be noted that these sectors use space data for communications and for PNT (Position, Navigation and Timing).

Manufacturing in Canada includes food processing, and there is an element of Agritech within this, although based on the statistics, even when combined with Agriculture as a whole, the proportion of Canadian GDP due to this sector is smaller than had been anticipated.

RANK	SECTOR	APPROX SHARE OF GDP	DETAILS
	Real Estate and Rental and Leasing	~13%	Includes residential housing, commercial properties, and rental services
2.	Manufacturing	~10%	Food processing, Automotive, aerospace, machinery production
3	Mining, Quarrying, Oil & Gas Extraction	~9–10%	Major exports include crude oil, natural gas, and minerals
4	Finance and Insurance	~7–8%	Banking, investment services, and insurance firms
5	Construction	~7%	Residential, commercial, and infrastructure development

Note 1: 2023-2024 data from Statistics Canada

5.3 Europe

When the GDP share per sector is analysed for Europe (or the EU), a similar figure of ~20% share of GDP is seen for the financial sector, and thus an opportunity for space data. Healthcare ranks highly, mainly due to the number of large pharmaceutical companies in Europe as opposed to the more integrated healthcare systems across Europe, and is as yet, less developed in the context of space data inward investment value.

Consumer goods in the context of the Eurostat data covers the food industry, food aggregators, food processors etc, and this then leads through to agriculture, thus potentially leading to space data inward investment opportunities.

The Technology sector as covered by the Eurostat data, is a wide ranging term, but covers space data opportunities in communications data as well as PNT (Position, Navigation and Timing).

RANK	SECTOR	APPROX SHARE OF GDP	EXAMPLE COMPANIES
	Financials	~18–20%	BNP Paribas, Allianz, Santander, AXA
2.	Healthcare	~15–17%	Roche, Novartis, Sanofi, Bayer
3	Industrials	~13–14%	Siemens, Airbus, ABB, Schneider Electric
4	Consumer Goods	~12–13%	Unilever, Nestlé, Heineken, LVMH
5	Technology	~7–8%	ASML, SAP, Infineon

Note 1: 2023 Eurostat data for the EU

5.4 MEA (Middle East and Africa)

Obtaining composite figures for GDP for the MEA was challenging. Surprisingly "Non-Oil and Gas Services" was ranked as higher than Oil and Gas for the Gulf States (sources: Statista, Economy Middle East and Reuters), and a small number of countries were responsible for the majority of GDP in Africa as a whole:

Based on World Bank Data, the following information was derived for Africa:

South Africa's primary sectors are financial, manufacturing and the mining industry.

Egypt receives significant revenue from the Suze Canal, given its status as a vital trade route. Tourism, driven by Egypt's rich history and culture, also plays a major role in its economy.

Nigeria and Algeria both depend on the energy sector, with Algeria primarily exporting natural gas, and Nigeria being a major crude oil exporter.

Ethiopia relies heavily on agriculture, with coffee serving as a key economic and export driver.

5.5 East Asia

The extent of the manufacturing sector in East Asia is significant, and whilst services dominate, the extent to which manufacturing plays a key role in GDP is apparent. With manufacturing, transport and logistics for raw materials, transports of assemblies and sub-assemblies, and shipping to end users also has an important role to play.

COUNTRY	SECTOR	DETAILS
Japan	Services (70%), Manufacturing (25%)	high-tech manufacturing
South Korea	Services (60%), Manufacturing (38%)	Tech-heavy industry, growing services
Taiwan	Services (55-60%), Manufacturing (35-40%)	Semiconductor hub, export-driven

Note 1: World Bank - World Development Indicators (WDI),
Note 2: International Monetary Fund (IMF) - World Economic Outlook (WEO),
Note 3: United Nations Statistics Division (UNSD) - National Accounts,
Note 4: Statistics Bureau of Japan,
Note 5: Statistics Korea (KOSTAT),
Note 6: Directorate-General of Budget, Accounting and Statistics (DGBAS), Taiwan,
Note 7: OECD (Organisation for Economic Co-operation and Development)

5.6 Australia

Australia's highest ranked sector by share of GDP is finance and insurance, mirroring that of the USA, Canada and Europe.

RANK	SECTOR	APPROX SHARE OF GDP
	Finance & Insurance	21%
2.	Healthcare & Social Assistance	13%
3	Construction	8%
4	Professional, Scientific & Technical Services	7%
5	Manufacturing	6%

Note 1: Australian Bureau of Statistics (ABS)
Note 2: Australian Government Treasury

5.7 Sectoral Mapping

Because of the variation in sectors between geographies, the companies were chosen based on a representative sample across the range of different industry sectors for where space data was either used or could be used, and where there was deemed to be potential investment potential that aligned with Scotland's strengths both generally in terms of skilled workforce and infrastructure and specifically in terms of Scotland's IT sector (e.g. data and cybersecurity) and Scotland's downstream data segment of the space sector.

The examples indicated in Section 4 provided the overview of the extent of applications using space data across sectors, and Section 5 has provided a level of direction for the mapping, taking into account the variation in geographical areas.

For the USA, Canada, Europe and Australia, as noted, the financial sector ranked highest in terms of share of GDP. This is consistent with mature, technological economies. This sector has applications that necessitate space data, and this is an area of strength in Scotland.

Whilst transport and logistics, energy and utilities and agriculture were separated out for Section 4, the research into the sectors in Section 5 has shown that these sectors are often blended across other sectors. Scotland's space data strengths in these sectors provides an opportunity for inward investment that would be worth pursuing. Natural Capital as a separate sector was not seen as a significant share of GDP, although it should be noted that elements of natural Capital will be incorporated into the Fintech / Financial sector through Carbon trading schemes and related applications.

When the main sectors from the geographical regions analysed are mapped against Scottish Strengths and Scottish Space Data Strengths, the following table presents the best approximation in terms of mapping. It should be noted, that the differences between geographical regions in terms of how they define sectors, means that the mapping cannot be a direct one-to-one mapping, hence the best approximation:

Sector	Scottish Strength	Scottish Space Data Strength
Fintech	★★★★	★★
Manufacturing / Industrials	★★★	★
Wholesale, Retail and Consumer Goods	★★	★
Construction	★	★
Healthcare	★★★	★
Mining and Hydrocarbon extraction	★★★★★	★★★
Agriculture	★★★	★★★★

6. Conclusions

The range of applications for which space data is used is extremely large, as is evidenced by the brief overview of the various industries and industry applications that use space data in section 4. The opportunity space for space data is amplified by the sector strengths on a regional geographic basis found in Section 5.

Previous research confirmed that the wealth of Earth observation space data alone holds unprecedented potential for organisations of all sizes, with the applications segment becoming more financially important. In all the regions evaluated, space data is already used by large organisations down to small startups, albeit that they are not always aware that they are using space data. This is especially the case for PNT space data such as GNSS data, since it works seamlessly in the background in smart phones, smart watches, SatNavs in cars, aircraft, trains, tractors and ships.

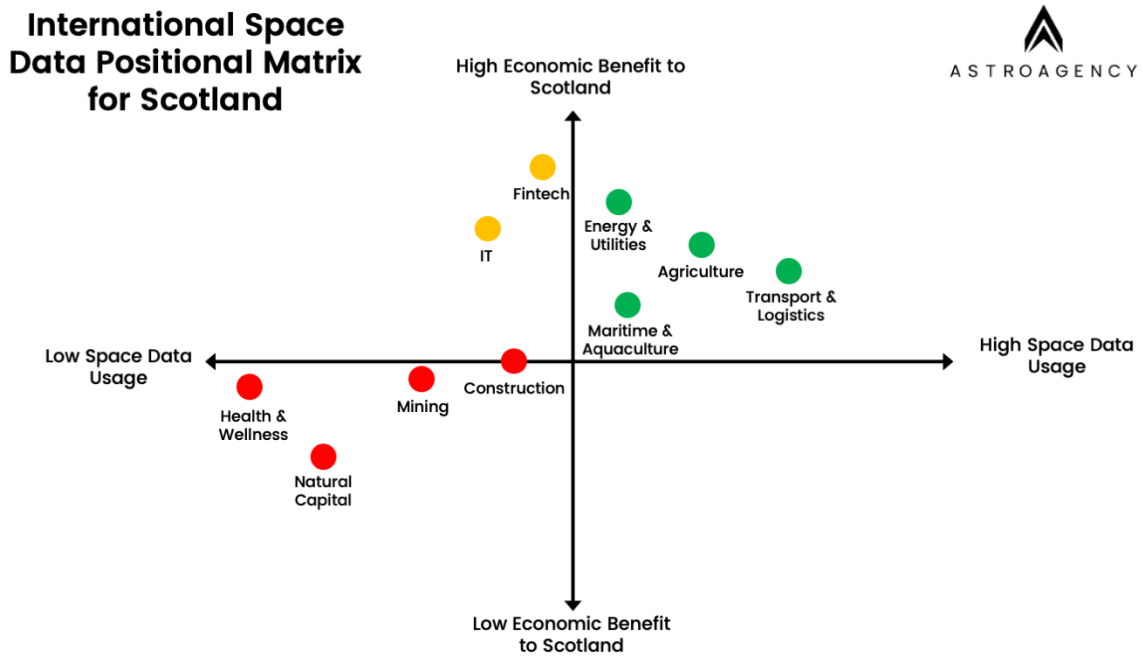
It was initially considered that it might be a challenge locating enough genuine examples of end user companies either using space data or who would benefit from using space data, and for whom inward investment into Scotland would be effective for them. In reality, uncovering such companies was less of a challenge than anticipated, with a greater challenge being discerning investment intentions.

The Fintech industry is an interesting case in terms of breadth of use of space data. Whilst this is Fintech outside of Scotland, the fact that there is a strong Fintech sector in Scotland provides an attractive opportunity for inward investment The space industry connections with the finance industry have moved from funding and investment of space ventures [5], to use of downstream space data such as meteorology data to support commodities futures markets, and Earth observation data which presents vast opportunities for the financial services sector to deepen their understanding of other sectors and initiatives, including sustainability and net zero, housing and socio-economic trends, and logistics assurance. Financial institutions can use space data to strategise their investments and provide them with confidence in their decisions and reporting. It was of note too that FinTech is rapidly growing outside of only finance as is the case with the insurance industry utilising FinTech as a method to improve underwriting, and risk assessments.

Other industries such as Mining, Construction and IT all provide companies that may benefit from investing in and with space data activity in Scotland, e.g., the existing data infrastructure, skilled workforce and good transport links, and with the synergy between big data, AI, and Machine Learning and space data, the existing talent pool in Scotland offers a ready-made investment pitch to international companies using space data who could benefit from an existing skilled workforce and infrastructure.

It has already been noted that the potential for space data use extends across many industries, with space data being utilised across all sizes of organisations and across countries. It should also be noted that not all end users subscribe to one type of space data, with multiple data sources and data sets being used for different companies depending on their needs. This is an

opportunity for Scotland to draw inward investment into Scottish space data companies, since the Scottish space data companies have the expertise to save international companies time and money by looking to locate in Scotland.



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Appendix A – Abbreviations and Acronyms

AVHRR	Advanced Very High-Resolution Radiometer
EO	Earth Observation
ESA	European Space Agency
ESG	Environmental Social Governance
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IoT	Internet of Things
IRNSS	Indian Regional Navigation Satellite System
LEO	Low Earth Orbit
LIDAR	Light Direction And Ranging
MODIS	Moderate Resolution Infrared Spectrometer
MRV	Monitoring Reporting Verification
NASA	National Aeronautics and Space Administration
NOAA	National
OMRV	Observation Monitoring Reporting Verification
QZSS	Quasi Zenith Satellite System
Rev	Revision
RADAR	Radio Detection and Ranging
RF	Radio Frequency
RTK	Real Time Kinematics
SAR	Synthetic Aperture Radar
SDI	Scottish Development International
SE	Scottish Enterprise
SG	Scottish Government
UK	United Kingdom
UK	United Kingdom Space Agency
US	United States

Appendix B - Wavebands

One of the key areas of space data covered in this report is Earth Observation space downstream data. The data can be imaged across a broad range of the electromagnetic spectrum. What this means is, that the data received is not restricted to the human visual range, but can be much broader, covering infra-red, ultraviolet, and even radar. Broadly, we differentiate the wavebands as per the following:

- Optical
- Infra-Red
- Hyperspectral
- Multispectral
- Synthetic Aperture Radar
- UV
- LIDAR

B.1 Infra-Red (IR)

In this context, Infra-Red is defined as the wavebands that are solely between Near Infra-Red and Thermal Infra-Red. In reality, Infra-Red imaging is frequently performed in conjunction with visible waveband imaging, thus resulting in either multispectral or hyperspectral solutions. There are good reasons for this approach: Infra-red imaging is lower resolution than visible imaging, and thus the visible imaging, overlaid on the infra-red image can enable higher resolution images to be extrapolated. However, this is harder to achieve with Thermal Infra-red imaging, where the separation in wavelength is far greater.

It should be noted too, that many platforms with Infra-red capabilities, are predominantly operating within the Near Infra-red waveband, rather than Thermal Infra-red waveband. The Near infra-red waveband is more commercially developed than Thermal infra-red, but lacks the insights that thermal Infra-red can provide.

B.2 Multispectral

In this context, multispectral imaging is defined as measuring spectra in distinct wavebands, which can then be overlaid to produce a composite image. For instance, a multispectral image may be composed of distinct images from multiple sensors at visible, near infra-red and far infra-red wavebands. NASA's Landsat and Terra, ESA's Sentinel and NOAA's weather satellites typically record multi-spectral imagery. In reality, the majority of Thermal Infra-red solutions fall into the multispectral solution space, since they work in conjunction with visible sensor systems rather than as distinct standalone solutions.

B.3 Hyperspectral

In this context, hyperspectral imaging is relatively new compared to Infra-Red and Multispectral sensing, and measures spectra across a continuous spectrum. The disadvantage of hyperspectral imaging is that because it covers such a wide waveband, it requires significant bandwidth and data storage.

Hyperspectral sensors capture data which can offer more detailed and precise information about objects that are observed within an image or composite image, based on material makeup. For example, these sensors can identify hazardous materials, as well as information likely to be of use for intelligence and defence, e.g. artificial versus real vegetation or decoy equipment

B.4 Synthetic Aperture Radar

Synthetic-aperture radar (SAR) is a type of radar that is used for high-resolution remote sensing and mapping of a planetary surface such as the Earth. Being radar based, it is capable of being used day and night, and being able to see through clouds.

Applications of SAR include topography, oceanography, glaciology, geology / geomorphology. As well as forestry where it can be used to determine forest height and biomass to assist with ESG through carbon accounting, as well as deforestation. SAR can also be applied to the built environment for monitoring infrastructure stability for structures such as bridges and dams. SAR is also used for environmental monitoring applications such as oil spills, flooding, and landslip detection.

A recent use of synthetic aperture radar imagery has been seen with Russia's invasion of Ukraine and the need for sensors that could penetrate thick clouds. The conflict has shown the value of synthetic aperture radar (SAR) imagery able to be used at night and through bad weather, a task not possible with optical sensors.

Space based Earth Observation applications require a wide range of different sensors in order to provide specific data. The data can then be analysed to derive insights relevant to the application. The following table provides an overview of the main types of sensors and their applications and outcomes:

Appendix C - Waveband Applications

To provide additional context to the wavebands described in Appendix B, applications and their outcomes are indicated for each sensor type:

Sensor Type	Application	Outcome
Multispectral	• Land cover mapping, • agriculture, • water quality	Detailed images capturing light in several wavelengths; used to identify materials, monitor plant health, etc.
Hyperspectral	Mineral exploration, vegetation monitoring	Images capturing light in hundreds of narrow bands; identifies materials based on light reflection patterns.
Synthetic Aperture Radar (SAR)	Land deformation, moisture content, forestry	Radar images capturing microwave energy; can see through clouds and work both day and night.
Panchromatic	High-resolution mapping, urban planning	Black and white images with high spatial resolution.
Thermal Infrared	Heat mapping, temperature variation, soil moisture	Images based on the heat emitted from objects; used for temperature mapping and detecting thermal anomalies.
LiDAR (Light Detection and Ranging)	Topography, forest structure, flood modelling	3D point clouds representing surface features; captures height data and topographical details.
Ultraviolet	Atmospheric studies, ocean colour monitoring	Images capturing ultraviolet light; helps in understanding atmospheric processes and monitoring ocean colour.
Microwave	Soil moisture, sea ice mapping	Images capturing microwave radiation; useful in soil moisture analysis and sea ice mapping.
Passive Microwave	Temperature profiling, precipitation measurement	Captures natural microwave radiation emitted from objects; used in meteorological studies.
Active Microwave	Oceanography, topography	Emits and then captures its own microwave radiation; provides data on wave heights, ocean topography.