Investigating UK public sector demand for Earth Observation technology

A summary of research co-funded by Geospatial Commission and Satellite Applications Catapult

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CONTENTS

EXECUTIVE SUMMARY

Earth observation (EO), particularly that collected from satellites, is a fundamental source of location data used by society today. It provides information about our planet at a frequency and coverage that is simply not possible from any other source. Currently, EO data is used across the UK public sector for a range of operational purposes, from environmental monitoring to emergency incident response. On a global scale, EO is essential for climate monitoring. EO data has the potential to offer significant additional value for the UK public sector.

A 2018 London Economics Study[1] estimated an average annualised benefit for the UK of £1bn from Satellite-derived Earth Observation across nine key civilian use areas[2]. This estimate includes £64m per year of direct operational value to the government.

Driven by new emerging technologies and increased technological capability, the EO imagery and services markets are rapidly developing in terms of imaging and processing capabilities and service models. This is reducing the barriers to entry for use of EO data, creating new opportunities for the UK public sector to unlock additional value for the taxpayer with this technology.

The Study

This study, jointly funded by the Geospatial Commission and Satellite Applications Catapult aims to understand what the biggest value opportunities are. It identifies and describes current and potential uses of EO data across the UK public sector and describes how EO data can be better leveraged to realise greater value.

The summary report presents evidence across two sections:

i. Characterising EO use across the public sector – identifying common themes from stakeholder engagement and summarising organisational EO maturity

ii. Opportunities and recommendations

The study is based on a multi-stage research process, using desk-based research and UK public sector stakeholder engagement, including workshops and interviews to identify public sector uses of EO data. All the use cases discussed are owned and delivered by UK public sector organisations. This study does not attempt to detail sponsorship activities (i.e., of academic research) or provide specific insight into the commercial market. These, however, remain key drivers of innovation and demand and should be considered as part of wider policymaking.

[1] London Economics (2018). Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020

[2] These were: Agriculture, Atmosphere, Built Environment, Coastal, Flooding, Forestry, Maritime, Meteorology, and Transport.

EO Maturity across the UK public sector

The study identified 300 UK public sector organisations, of which 125 were current or potential users of EO data. Across these 125 organisations, 136 active use cases were captured, of which 62 were categorised as operational and 74 as exploratory. The 125 organisations identified have been classified according to their 'maturity' (experience or expertise) in EO data use.

The most mature users of EO data are those organisations with a longstanding requirement that can only be met through the frequency, and coverage offered by satellite data, e.g., Ministry of Defence, Rural Payments Agency, and the Met Office. These organisations have invested significantly in developing their in-house capabilities and are therefore well positioned to take advantage of the market developments to support their core requirements. This explicit requirement has enabled them to develop and implement effective business cases for activities such as procuring commercial high-resolution EO data. Though impactful, mature users are currently a minority within the wider UK public sector.

Current and evolving demand for commercial high-resolution EO data underpins 30% of the use cases. This 30% does not include many of the emerging use cases, including future agricultural systems and land management schemes, achieving Net Zero, national climate reporting, and sustainable finance where commercial EO data and services are likely to be critical to their effective implementation.

The largest group identified were organisations with a moderate and growing EO maturity that can utilised to improve the efficiency of their operations. Within this group, maturity has accelerated fastest in organisations that have actively invested in embedding day-to-day use of these data across disparate policy areas. Notable examples include Defra's EO Centre of Excellence and the Living Wales programme, both of which are utilising open EO data provided under the European Commission's Copernicus Programmes. For example, Defra has invested in a data service that processes raw Copernicus data into Analysis Ready Data (ARD) to provide a common operating view across Defra group organisations/agencies, reducing the need for individual Defra agencies to use specialist tools and expertise to use the data. This ARD has the potential to underpin 88 of the use cases identified across 32 UK public sector organisations.

The lowest levels of maturity were found within those organisations that have limited capacity to invest in considering the opportunities that EO offers within their organisation. For example, there is a general belief that EO has a clear role to play in supporting emerging policy areas such as Net Zero, greenhouse gas inventorying, and sub-national levelling-up analysis, however, potential EO solutions have yet to be explored. Technical implementation with use case operations also acts as a barrier to several other lower EO maturity organisations.

Barriers to developing EO maturity

Several common challenges were identified through the interviews. Some of these were universal across all organisations, and some were common across organisations at similar levels of maturity.

The universal challenges are interlinked and progressive, including:

- **Understanding of tool and platform capability –** There is evidence that the capabilities of new data systems are either unknown or may be misinterpreted by end users.

- **Gauging technological possibilities** - There is limited awareness of maturing technical developments in the wider EO sector that might enable improved integration of EO into the broader UK public sector geospatial landscape.

- **Establishing a case for investment** – Exploring technological feasibility was consistently considered less challenging than establishing a robust case for investment in EO data and technology.

- **High data cost** – In the majority of stakeholder interviews the primary blocker to the adoption of high-resolution commercial EO procurement was perceived high data cost. A range of high-resolution commercial EO data trials are being undertaken across the UK public sector with significant overlap in suppliers, use cases, technical approaches, and geographic coverage of operational scope.

For users with higher EO maturity, there are a range of established means for procuring EO data and services from the market. The interviews identified several specific challenges associated with UK public sector use of commercial EO data which were:

- **End User Licensing Agreement (EULA) considerations -** A key blocker identified for wider use of data procured under existing contracts is the uncertainty of restrictions around licensing agreements and practicalities of data sharing.

- **Ensuring value for money procuring independently** - Due to the nascency of the UK public sector requirements for EO, there is a concern about how public sector organisations can ensure that they are getting value for money through their procurements of commercial data in the absence of benchmarking as is often the case for more developed products and services.

- **Perception of the inability for appropriate data sharing** – Whilst the study confirmed that ensuring the protection of security sensitivities is a clear requirement for any coordinated access mechanism, no evidence was found to indicate this being a blocker in practice. Rather the counterfactual was the case with the potential exposure of UK foreign policy interests from patterns of requirements being overseen by commercial operators being a greater risk and one that was manifesting itself today.

Within the group of organisations with moderate and growing EO maturity, the single biggest challenge in realising greater benefits from EO was the lack of efficient mechanisms for sharing experiences and lessons learnt from trial/proof of concept initiatives across organisational boundaries. This can make it difficult to make investment cases to secure funding.

Opportunities & Recommendations

Based on the key findings summarised above, the report draws out three key opportunity areas and recommendations for the UK public sector to consider that will realise greater value from EO data:

1. **Explore how current UK public sector EO data services can evolve and be positioned to efficiently meet growing demand:** The introduction of EO data services has significantly reduced the barriers to the use of openly available EO data for UK public sector bodies that access them (e.g., EO data from the Copernicus Programme). Where data services have been established (particularly those that process raw data to analysis-ready data (ARD) e.g., Defra EO Data Service (EODS)), there are opportunities for further evolution and standardisation of the services across organisations and opportunities to unlock increased value. This might include simplified access, access to an increased number of data sources as well as value-added data products. This would encourage skills growth and diversification, promote greater use of the data, reduce overheads from duplicate services, and ensure maximum value for money is derived from these services.

2. **Assess the investment case for a coordinated procurement mechanism for commercial EO data to meet current and emerging policy requirements:** There is established demand in the UK public sector for very high-resolution commercial EO data. In several cases, access to this data has already been piloted, with positive results. Broader engagement with this data across the UK public sector is likely to result in increased efficiency in existing EO use cases, and new insights to inform emerging use cases. However, there are significant barriers to broader adoption, including market understanding, licensing considerations, and availability of in-house skills and expertise to both procure and then use the data. Furthermore, there is already a risk of siloed duplicated procurement, where different organisations are purchasing similar products, creating market spending, resource, and skill inefficiencies. The UK public sector should consider mechanisms to ensure that it is aware of the opportunity and realises the best value for money in its procurement and use of this data. A coordinated procurement approach would have the additional benefit of helping to identify the gaps within commercial offerings in the market to help inform considerations of the capability requirements of any future UK sovereign missions.

3. **Enhance knowledge sharing and collaboration between UK public sector bodies to encourage greater uptake of data amongst those organisations with a lesser and moderate EO maturity:** Improving the exchange of expertise and insight across the UK public sector is one of the most cost-efficient means of strengthening understanding and use of EO data. Several groups already exist to this end and are very successful in their promotion of knowledge sharing. To build on this success, further collaboration can be pursued within and between these groups, raising awareness more widely of the potential of access to open and commercial EO data, and the variety and maturity of use cases across the UK public sector. Collaboration with and alignment to technology, research, and innovation activity (e.g., Catapults, KTN, Research Councils) should also be sought. Taking such a targeted approach would help the UK public sector reduce duplication, support investment, and drive faster and more efficient delivery of policy priorities, particularly in emerging policy areas such as Net Zero and Levelling Up.

ACKNOWLEDGEMENTS

The study was funded collaboratively by Geospatial Commission and Satellite Applications Catapult and delivered by a team of staff from both organisations over the course of the latter half of 2021**.**

This report builds on the well-established and continuing work of stakeholder organisations and individuals across the public and private sectors who have set the foundations for understanding and evaluating use of Earth Observation across the UK public sector.

We are particularly grateful for the time of stakeholders across the UK public sector who attended the interviews and workshops. The content of this report is derived from their insights captured through interview(s) and associated exchanges.

Stakeholder organisations engaged throughout the study:

Broxtowe Borough Council

Defence Geographic Centre

Department of Agriculture, Environment and Rural Affairs, Northern Ireland

Department for Business, Energy & Industrial Strategy - Greenhouse Gas Inventory team

Department for Environment, Food & Rural Affairs – Chief Scientific Adviser's Office, Defra Earth Observation Centre of Excellence (Defra EOCoE)

Department for Environment, Food & Rural Affairs - Group Corporate Services, Digital, Data & Technology Services (DDTS)

Environment Agency

East Dunbartonshire Council

Foreign, Commonwealth & Development Office (FCDO)

Foreign, Commonwealth & Development Office / Office for National Statistics (FCDO-ONS) - Data Science Campus

Geospatial Commission

Hampshire County Council

Home Office

Joint Nature Conservation Committee (JNCC)

Met Office

Ministry of Defence (MOD)

Marine Natural Capital and Ecosystem Assessment

Ministry of Defence - National Centre for Geospatial Intelligence (NCGI)

Natural England – including Living England Project

Natural Resources Wales (NRW)

Ordnance Survey

Terrestrial Natural Capital and Ecosystem Assessment

Rugby Borough Council

Rural Payments Agency (RPA)

North Yorkshire Police

Scottish Government

South Wales Fire and Rescue Service

UK Health Security Agency (UKHSA)

UK Hydrographic Office (UKHO)

UK Space Agency

MOD - UK Space Command, Royal Air Force

Welsh Government – Including Living Wales Project

SECTION ONE: INTRODUCTION

PROJECT PARTNERS

About the Geospatial Commission

The Geospatial Commission, 'the Commission,' was established in 2018 as an independent, expert committee responsible for setting the UK's Geospatial Strategy[3], promoting the best use of geospatial data, and coordinating public sector geospatial activity. Its aim is to unlock the significant economic, social, and environmental opportunities offered by location data and to boost the UK's global geospatial expertise.

The UK Geospatial Strategy, published in June 2020, sets out four key missions:

- Mission 1: Promote and safeguard the use of location data.
- Mission 2: Improve access to better location data.
- Mission 3: Enhance capabilities, skills, and awareness.
- Mission 4: Enable innovation.

The UK Geospatial Strategy commits the Geospatial Commission to explore ways to rationalise the public sector's procurement of Earth Observation data and services, as part of its Mission 2: Improve Access to Better Location Data.

The Geospatial Commission coordinates public sector access to critical foundational location datasets (including remotely sensed data), via initiatives such as the Public Sector Geospatial Agreement with Ordnance Survey, the Aerial Photography Great Britain (APGB) agreement with Bluesky, Getmapping, and Airbus, and the Public Sector Licence for the Postcode Address File (PAF) with Royal Mail.

About Satellite Applications Catapult

The Satellite Applications Catapult (Catapult) is a unique technology and innovation company, boosting UK productivity by helping organisations harness the power of satellite-based services. Our Mission is 'To innovate for a better world, empowered by space'.

We are driven by how our actions help the organisations we work with, both large and small, bring new services to market, and to realise the potential from space. By connecting industry and academia, we embrace a pioneering, agile, collaborative, and entrepreneurial spirit that gets new research off the ground and into the market more quickly to deliver game-changing results.

[3]Geospatial Commission (2020) Enhancing the UK's Geospatial Ecosystem.

Located near Oxford, we operate globally to deliver solutions that bring together local and UK entities from policy, technology, and science to tackle critical challenges across markets including agriculture, extractive industries, infrastructure, water, energy, and health.

The satellite sector is undergoing transformational changes, leading to a greater amount of accessible data, higher spatial resolutions, automated analytics, and diversified business models. The Catapult is at the forefront of this revolution, pushing the bounds of both technology and applications.

RATIONALE & SCOPE

Context

Satellite-derived EO is the focus of this study. All references to 'EO' and related terminology are used interchangeably and refer to satellite derived EO exclusively, unless otherwise stated.

EO data is operationally used across the UK public sector for a range of purposes, from environmental monitoring to emergency incident response. London Economics anticipated total spend on satellite-derived EO by the UK government to reach £1.2 billion by 2020 across nine key civilian use areas. Equating to a spend of c£175m p.a. since 2014, the study, published in 2018, estimated an annualised benefit to the UK of £1bn and a direct operational benefit of £64m p.a. to the Government[4].

Increased recognition of the value of EO across the public sector has raised interest and investment in new uses. Maturity in the use of EO has accelerated fastest in organisations and departments that have actively invested in embedding day-to-day use across disparate policy areas. This is most notable in Defra's EO Centre of Excellence and the Living Wales programme.

The pandemic has also brought into focus the high value of location data and its broad potential for new applications across the public sector.

Outside of the public sector, the EO imagery and services markets are rapidly developing in terms of imaging and processing capabilities and service models. Investing in publicly-funded EO capabilities and initiatives requires greater awareness than ever before of this dynamic private sector landscape in order to deliver value for the UK taxpayer[5].

Why now?

The appetite for exploration of EO use has grown in recent years and the maturation of technology has brought costs down, allowing new EO providers to enter the market, which

[4] London Economics (2018). Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020.
[5] Geospatial Commission (2020). Enhancing the UK's Geospatial Ecosystem.

has increased competition, helping to reduce costs further. There is an argument for increased investment in coordinating both exploratory and operational EO activities to help realise further value.

The COVID-19 pandemic has also brought into focus the high value of location data and its broad potential for new applications across the public sector.
With the convergence of the above technological, market, and socio-economic conditions, there is now a window of opportunity to capitalise on this public and political recognition, and to harness this interest to enable better access to higher quality products for the public sector, ultimately resulting in more effective and efficient services. As focus turns to key challenges, including pandemic recovery and Net Zero following COP26, there is an opportunity now to champion the possibilities of EO data-informed innovations and services in these areas. This report seeks to build understanding and a pathway towards realising these opportunities.

Scope of the study

This study identifies and describes the uses of EO data across the UK public sector. The work followed a multi-stage process of use case identification and stakeholder engagement, including workshops, interviews, and desk-based research. The aim is to establish a foundational evidence base to inform the public sector EO community and the Commission's developing work on the current and potential use of Earth Observation (EO) data within the public sector.

Beyond the current study

This evidence-gathering process will build an understanding of public sector needs and support the Geospatial Commission and others to define the scope of activities they may pursue underpinning the UK's Geospatial Strategy[6].

It is hoped that this research supports ongoing related work across government, including but not limited to DEFRA's EO Centre of Excellence and EO Data Service, the BEIS Space Directorate's study of UK EO capacity, the UK Space Agency (UKSA)'s study of EO public sector infrastructure, and Northern Ireland's emerging EO Steering Group.

Note: Satellite-derived EO is the focus of this study. All references to 'EO' and related terminology are used interchangeably and refer to satellite-derived EO exclusively unless otherwise stated.

[6] Geospatial Commission (2020). Enhancing the UK's Geospatial Ecosystem.

DEFINITIONS & ACRONYMS

This section defines relevant terminology and acronyms based on the authors' understanding and what is thought to be useful for digesting the findings of the study. The same terms may be defined differently by other users or publications.

Earth Observation (EO): The gathering of information about planet Earth's physical, chemical, and biological systems. It involves monitoring and assessing the status of, and changes in, the natural and man-made environment. The potential of terrestrial, airborne, and satellite-derived EO has driven policy and strategy considerations across different sectors.

Note: Satellite-derived EO is the focus of this study. All references to 'EO' and related terminology are used interchangeably and refer to satellite-derived EO exclusively, unless otherwise stated.

Department: Her Majesty's Government (HMG) department that is currently an active user of EO technology.

Organisation: Public sector organisation directly associated with HMG that is currently an active user of EO technology.

Use Case: Explicit or representative use of EO technology that directly or indirectly supports business drivers of the associated public sector organisation or department.

Research and Development (R&D) Use Case: The use of EO technology that is aligned with operational HMG business drivers (i.e., not fundamental research) as part of a trial or pilot exercise.

Operational Use Case: The use of EO technology that is aligned with operational HMG business drivers (i.e., not fundamental research) and is established as a business-as-usual practice.

Resolution: The nominal ground sampling distance, i.e., granularity of spatial detail, of an EO dataset. **Very high resolution** is nominally used to refer to finer than 1 m resolution, **high resolution** to around 3-5 m resolution, **moderate resolution** to 10 to 30 m resolution, and **coarse resolution** to lesser granularity.

Multispectral: Used to describe data sources or datasets that comprise several information bands from regions of the electromagnetic spectrum that lie outside of the visible range (i.e. red, green, blue) and have been passively collected by a sensor.

Hyperspectral: Used to describe data sources or datasets that comprise a very large number of information bands from regions of the electromagnetic spectrum and have been passively collected by a sensor.

Synthetic Aperture Radar (SAR): An active sensing technology using microwaves to illuminate the surface - impervious to cloud cover and other atmospheric conditions.

Light Detection and Ranging (LiDAR): An active sensing technology carried on airborne and satellite platforms, illuminating the surface with pulses of visible light to provide highly accurate observations of atmospheric and surface conditions.

Higher-level data products: Information datasets, typically geospatial, that have been derived from EO datasets.

Frequency: The cadence or temporal resolution with which a sensor acquires data.

Aerial Photography: A remote sensing platform that sits within some definitions of EO, but for the purposes of this study is a separate category of data capture.

Aerial Photography Great Britain (APGB) and the Public Geospatial Agreement (PSGA): collective agreements coordinated by Geospatial Commission for public sector access to critical foundational location datasets.

EO data & services markets: Used to refer to two broad categories of the EO commercial marketplace. The EO data market includes the capture and provision of imagery and services market the various elements of value-adding steps involved in deriving additional levels of information.

Copernicus programme: Copernicus is the European Union (EU)'s Earth observation programme coordinated and managed for the European Commission by the European Union Agency for the Space Programme in partnership with the European Space Agency, the EU Member States.

End User Licence Agreement (EULA): an agreement between EO data supplier and end user describing the terms under which the user may use and disseminate data and/or derived products (i.e., a processed image or extracted land cover map).

EO Maturity: The maturity of EO use of the departments and organisations considered was based on the evidence and insight gathered in advance of and throughout the study. These classifications are intended to be indicative rather than prescriptive, and so were not subject to an objective framework or criteria.

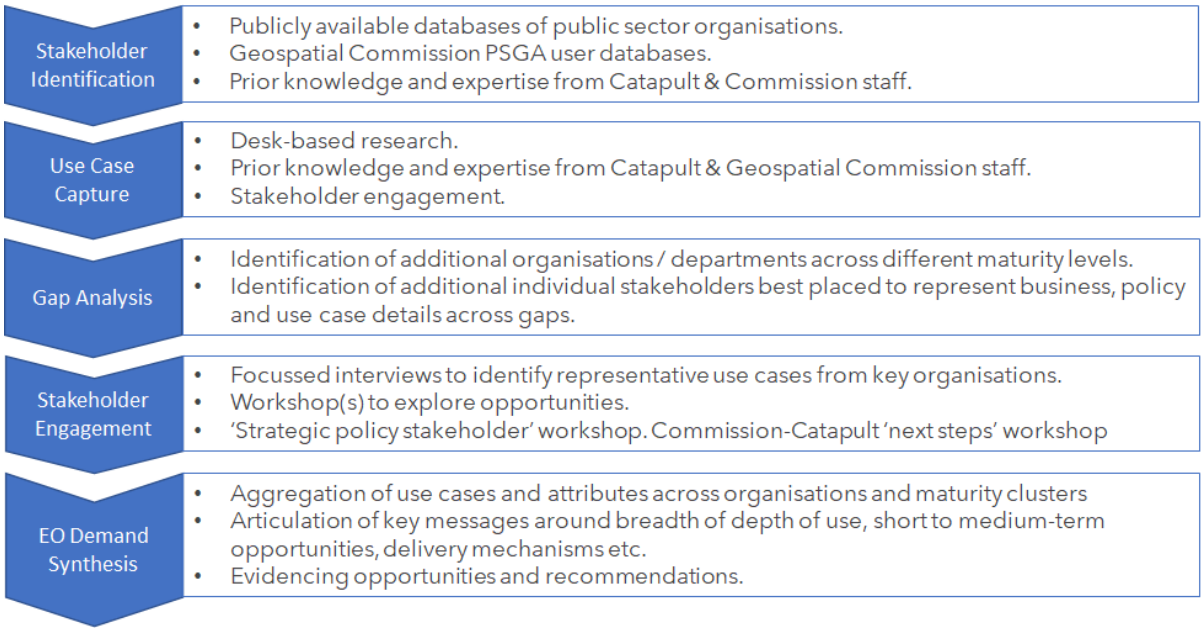
GEOINT (Geospatial Intelligence): A term used by the MOD to describe Intelligence derived from the exploitation and analysis of geospatial information, images and other data to describe, assess, or visually depict geographically referenced activities or features. GEOINT includes imagery intelligence and the production or analysis of geospatial information.

Systems of systems: A collection of independent systems, integrated into a greater system to deliver unique capabilities.

Higher-level EO imagery data products: Are referencing EO imagery datasets with the highest level of processing applied, such as Analysis Ready Data products.

APPROACH SUMMARY

The study followed an iterative approach (Figure 1) within a Commission and Catapult-defined 'research framework' (Appendix 2) designed to ensure outputs were generated in close alignment with the desired outcomes and impact of the study.



Desired Outcomes

The envisaged impact of this summary report is to build an evidence base that can be used to **inform and support robust, actionable, cross-government policy interventions** regarding EO data. The understanding and evidence of EO demand and opportunity across the public sector have been improved by considering the following questions:

- **How is EO technology used across the public sector?** Who uses EO data, what EO data do they use, how do they access EO data, and what do they use EO data for?

- **How can optimal use of EO technology be realised within the public sector?** What are the trends in the public sector EO data demand, what are the trends in EO data supply? What support services currently exist? Where could targeted interventions be made to improve access and use?

SECTION TWO: CHARACTERISING EARTH OBSERVATION USE ACROSS UK PUBLIC SECTOR

- 300 public sector organisations considered
- 125 identified with current or potential EO opportunities
- 67 organisations working on 136 active EO use cases
  - 62 operational EO use cases
  - 74 exploratory EO use cases

SUMMARISING EARTH OBSERVATION MATURITY

To summarise EO maturity across the public sector we have drawn statistics from the collated use cases, organisational summaries from our interviewees, and internal Catapult and Commission experiences.

The view we present as a summary is intended to be representative - not comprehensive - of current EO demand and potentially unexplored short-term opportunities. We believe the underpinning evidence base to be sufficiently representative of the public sector community and its use, to inform further policy development and provide a platform on which future studies may build.

The maturity of EO use across the departments and organisations considered was based on the evidence and insight gathered in advance of and throughout the study. These classifications are intended to be indicative rather than prescriptive, and so were not subject to an objective framework or criteria. This report assigns organisations to maturity 'clusters' based upon:

- Access to EO (and supporting) skills and expertise
- Procurement of EO data and services
- Longevity of organisation mandate
- Number of operational EO use cases
- Overall reliance on operational EO use cases in delivering policy mandate

Some stakeholders and organisations who are recognised as critical enablers of EO adoption in the public sector have not been included within the scope, as they were not judged to be direct users of EO data, these include: funding bodies and research councils, committees, and centres of excellence. This study was, however, grateful for the insights of some of these stakeholders in the later stages of stakeholder engagement.

0A. **A large number of detailed EO operational, exploratory and potential use cases are identified through the study across 125 public sector organisations and departments.**

0B. **A limited number of organisations were identified with very mature capabilities**, delivering operational services that have a critical EO dependency. These included MOD groups such as Defence Geographic Centre (DGC), National Centre of Geospatial Intelligence (NCGI) and UK Hydrographic Office, certain areas of the Defra group - such as the Rural Payments Agency (RPA) - and the Met Office. Demand for access to EO data and services within these organisations is significant and expected to be sustained indefinitely. These mature organisations often supply datasets derived from EO which are used by other government departments, such as weather forecasts from the Met Office.

0C. **A larger number of use cases overall are associated with the high maturity organisations**, and a greater number still with those considered of moderate maturity. These groups have a greater share of use cases considered exploratory in nature, and it is in **improving the efficiency of translating these into operational use cases that would result in the greatest impact from any coordinated intervention**(s) in EO use across the public sector.

0D. Lesser maturity organisations accounted for the smallest share of captured EO use cases overall, although stakeholder engagement revealed that often this is due to a **lack of capacity available to invest in definition of the opportunity**. These organisations are also much more likely to be indirect beneficiaries of EO data, products and services invested in by other public sector organisations.

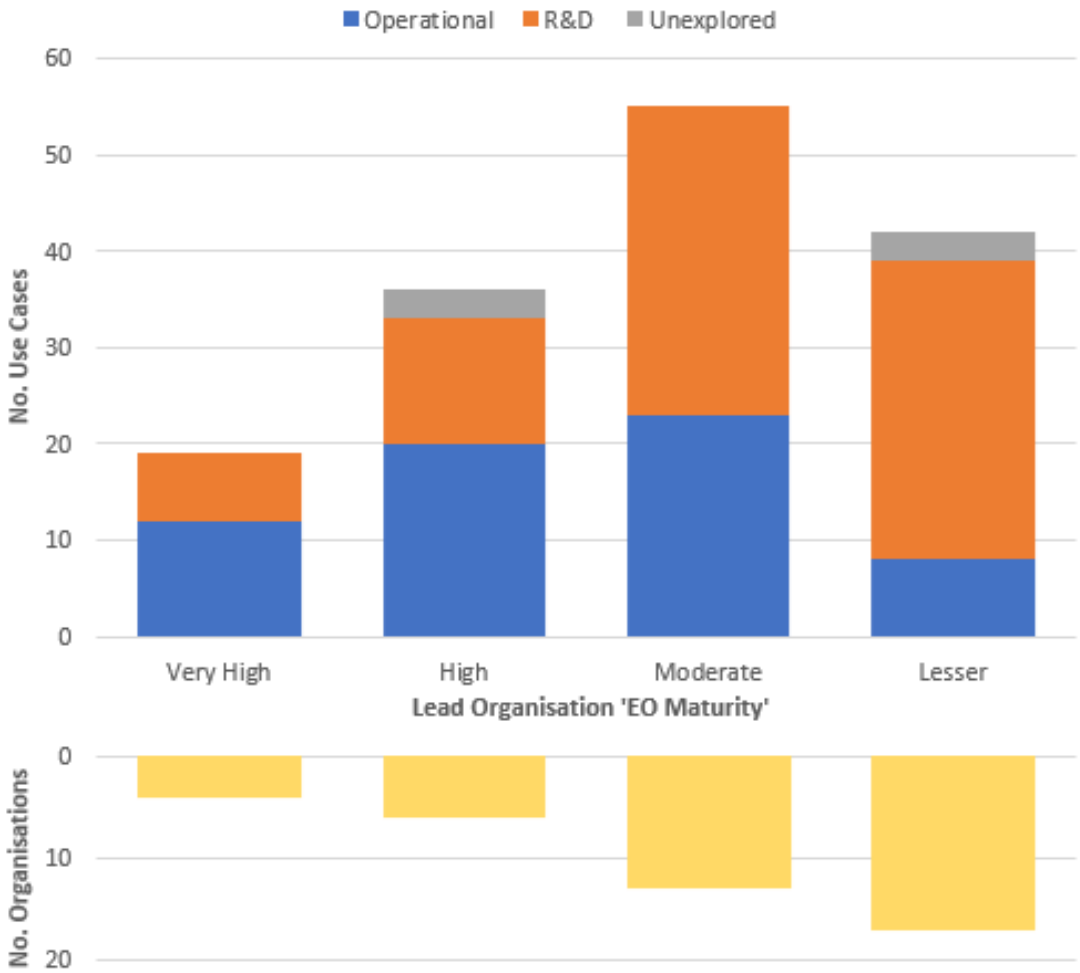
0E. **The small proportion of use cases associated with lesser EO maturity organisations relative to their share of organisations considered is an unsurprising yet important finding of the study.** Some of these groups are associated with emerging policy areas such as net zero, biodiversity net gain, and greenhouse gas inventorying, in which there is a clear role for EO that is still in the process of being defined. The report touches upon some of these themes and notes that increased visibility across the public sector should be accorded to these emerging uses of EO. **A key challenge for any co-ordinated public sector procurement case lies in anticipating this potential future demand**.

0F. Groups of lesser EO maturity **are exploring consistent questions around the technical feasibility of using EO** that have already been addressed elsewhere in the public sector. In almost all cases, the stakeholders the study engaged with from these groups said that they would benefit greatly from simply having greater visibility of EO use cases across the sector.

0G. **All organisations were found to be increasingly well positioned to be**

well-informed individual procurers of EO capability services, and not just EO data or imagery. As market capabilities rapidly develop, efficiently evaluating maturing offerings to the public sector will be a key requirement for satisfying demand for EO across emerging policy themes.

Figure 2. *Histogram of captured use cases per organisation EO maturity and the current status.*



The maturity summary and statistics drawn from the research offer a necessarily limited perspective of the captured use cases, tailored to support messages along common themes identified throughout our stakeholder engagement (Table 1).

Theme	Rationale
1: OPEN DATA INFRASTRUCTURE &Tools	Demand-driven **prior investment in UK public sector EO infrastructure has aimed to provide more efficient and consistent access** to openly available EO data whilst also mitigating duplicate processing efforts. Stakeholder insights captured around aerial photography and LiDAR provision are also briefly captured under this theme.
2: PROCURING COMMERCIAL HIGH-RESOLUTION DATA	**The study evidences a strong demand - and captures initial requirements - for** coordination of commercial EO data procurement across the UK public sector.
3: UNDERSTANDING & ENGAGING INDUSTRY	The study encountered **significant demand for a more coherent approach across the UK public sector** as a whole to support improved awareness, understanding, and evaluation of EO data and services market capabilities.
4: SKILLS, TRAINING & KNOWLEDGE EXCHANGE	**Improved awareness and understanding of EO activities, capabilities, business cases and stakeholders** across the UK public sector was consistently identified as an area to be improved upon and a notable barrier for maximising the potential return on investment from UK investment in EO.

***Table 1**. Summary of common opportunity and challenge themes expanded on through the research.*

Other potential themes include:

- **Technical applications.** Aggregating common technical applications and associated processes across use cases would support scoping of value-added service procurement from industry or targeted upskilling to maximise efficiency across organisations and departments.
- **Thematic applications.** Exploring thematic categorisation and tagging of higher-level applications or products could maximise the potential for a holistic and thematically driven approach to EO innovation.
- **Departmental aggregation.** Attributes have not been aggregated beyond the organisational level. Exploring which departments have the greatest variance in current and anticipated use would make for a useful progression of the study.

THEME 1: OPEN DATA INFRASTRUCTURE AND TOOLS

The majority of UK public sector use cases discovered for EO data use open data. This first theme explores the data available, how access to it is enabled, and the challenges UK public sector users face. The principal source of open EO data considered is the Copernicus Programme, though many other sources of satellite EO data are being utilised by the public section, of note is the Landsat Programme of National Aeronautics and Space Administration (NASA), as well as the coarser spatial resolution satellites utilised for weather predictions by the Met Office. This section also briefly accounts for UK public sector access to aerial photography data which, whilst not open, is currently made freely available to the GB public sector via coordinated procurement.

A note on Copernicus, EODS and SARD

Open EO data is collected by Sentinel-1 and Sentinel-2 satellites and accessed through the Copernicus Programme, conducted by the European Space Agency. The Copernicus Programme is the name of the European Union's EO programme, managed and delivered through the European Union Agency for the Space Programme and the European Space Agency. Copernicus data is publicly available for free online within 24 hours of capture. In addition to the 27 EU member states, third countries can also participate in the Copernicus Programme, by either contributing to the Programme budget, or providing data access in exchange. Participation in the programme enables special access to Sentinel data, including faster access to captured data (i.e., instead of a 24-hour lag time).

In 2020 two new EO open data services were set up within the UK public sector: the Earth Observation Data Service (EODS), run by DEFRA for its agencies in England, and the Simple Analysis Ready Data Service (SARD), run by JNCC for Scotland and Northern Ireland. These initiatives provide a processing service, enabling certain UK public sector organisations (e.g., Defra group and organisations in Scotland and Northern Ireland) access to analysis-ready versions of the open data that can then be more easily integrated into analysis and policy making. These services target common public sector barriers to use of open EO data, such as processing costs, storage challenges, the need for in-house technical expertise, and knowing what data is available, and where to find it. EODS provides processed data and holds an archive holding data up to 18 months. SARD provides processed data produced using the same methods and standards as EODS, and to promote the service JNCC also provide user guides and webinars.

1A. **Openly available EO data underpins 88 use cases across 32 public sector organisations. DEFRA group, in particular, have become major adopters of Sentinel-2 and Sentinel-1 Copernicus data, with a significant number of use cases across DEFRA relying upon these two data sources.**

1B. Existing investment in public sector EO infrastructure - most notably EODS and SARD - has aimed to provide more efficient and consistent access to openly available EO data whilst also mitigating duplicate processing efforts.

1C. Stakeholder insights captured public sector EO ARD use, as well as other open data programmes and tools and tangential messages around aerial photography and LiDAR provision.

EODS & SARD Service

1D. EODS and SARD were the two elements of the existing public sector EO data infrastructure discussed most across stakeholder engagements. EODS is accessible to the Defra group and SARD is accessible to organisations in Scotland and Northern Ireland.

1E. Whilst similar in their purpose, aims and data provision, **practical differences in functionality exist between EODS and SARD**.

"The business case for the EODS is primarily to embed EO into day-to-day business" (Defra EOCoE)

1F. Many stakeholders noted the **potential efficiency gains** that could be made **through coordinated production of open EO ARD** across the public sector.

"Ideally, the optimal approach to ARD production is at the UK level to avoid duplication of efforts." (Scottish Government)

1G. Several conversations concerned the suitability of expanding this type of service more widely across government; though many thought it would be a desirable service. The Defra EOCoE recognised this opportunity though voiced some of the barriers.

"Challenges exist around a joint procurement business cases with stakeholders such as devolved administrations and other departments; e.g. who pays for it and what are the licence restrictions." (Defra EOCoE)

1H. Several **organisations run operational use cases that do not utilise EODS despite having access**. They employ other services e.g.. Google Earth Engine (Natural England-Living England) and the Alaska Satellite Facility (RPA - CROME).

1I. Across the interviews, **five areas of suggested improvements** to enable more EO use cases to take advantage of EODS were captured:

I. **Archive length**. At present EODS only holds an 18-month archive of data. Given a significant number of use cases depend on change detection over multiple years, there is significant potential value in broadening the time series held within the archive.

"One of the key requirements of the environmental sector is to look at trends, for which a long time series is required" (JNCC)

II. **Analysis environment**. Investment in analytical capacity and better integration with other portals and platforms was mentioned as a useful pathway to increase ease of use by the Environment Agency:

"EODS is a good portal for discovery but somewhere (infrastructure, tools, etc.) to process is still required, and an overhead on a case-by-case basis" (Defra EOCoE).

III. **Additional datasets**. EODS and SARD at present only provide processing services for Sentinel-1 and Sentinel-2 data. User feedback has highlighted a demand for more products to be available, including Sentinel-3 data, commercial data, LiDAR data and other derived products in one system.

IV. **Data quality**. One significant operational use case initially employed EODS data in its work, but then moved to use Google Earth Engine data instead, citing data quality issues with the EODS data. Investment to ensure high quality of data may broaden the applications of EODS and SARD services.

V. **Continuity assurance**. Several organisations noted institutional hesitancy when developing processes which depend on these data services, due to concern regarding long-term funding guarantees and continuity of supply. Confidence in data supply is critical for potential use cases to receive investment and for exploratory use cases to become operational.

Tools & Platforms

1J. EO demand was consistently characterised by a **desire to be able to treat EO as simply another data source** within existing and emerging policy-led data science problems.

"EO should be part of a bigger data system and treated the same when it comes to licensing etc.'" (JNCC)

1K. Within Natural Resources Wales (NRW), efforts are focussed on **enabling access to a self-service tool kit** promoting and training others within the organisation to integrate remote sensing technologies, including satellite EO.

1L. The **Living Wales programme** delivers environment variables that can underpin multiple policy requirements within a clear applications framework. The study found the Living Wales programme to be the single individual programme that brought EO imagery furthest along the value chain across the maximum range of policy areas.

1M. The **smaller size and increased flexibility of devolved administrations such as the Welsh Government has fostered sustained innovation** in adopting and

implementing EO tools and platforms against explicit policy requirements.

"The relatively small size of Wales makes it easier to work at a national scale, enabling more impact as well as efficiency with limited resource. The position and structure of the Welsh Government also means departments are well connected enabling collaborations." (NRW)

1N. Defra DDTS, through delivery of EODS, actively encourages users to make use of contemporary data streaming approaches for improving efficiency in accessing Sentinel-1 and Sentinel-2 data sets within readily available GIS tools.

"Data analysts do not yet have the capabilities (tools & skills) to be able to consume and use data via API services, including restful query services and OGC Web Feature Services. This leads to delays in accessing data and a propensity to download data, reducing the value add of the EODS" (Defra DDTS)

1O. In practice, **common challenges were identified in maximising exposure of EO data disseminated across the public sector**, whether for experienced remote sensing and geospatial users or domain-agnostic data experts.

i. **Understanding tool and platform capability**. Where investments have been made to date there is evidence of misinterpretation of capability of data systems. The need to improve awareness of the best practices for using EODS and other systems came through strongly during our stakeholder engagement with Defra DDTS. A similar reluctance to embrace use of new tools and services (i.e., data streaming) was described by NRW.

ii. Gauging **Technological possibilities**. The study repeatedly encountered the desire for coordinated investment to move beyond simply EO data provision, for example through continuation of the Defra Open Data Cube (ODC) trial, a limited exploration of the potential for using ODC technology for the generation of higher-level EO products. There was, however, limited awareness of maturing technical developments in the wider EO sector that might enable improved integration of EO into the broader public sector geospatial landscape (i.e., cloud native geospatial developments).

iii. **Establishing a case for investment**. Exploring technological feasibility was consistently considered less challenging than establishing a robust case for investment in EO data and technology.

A note on aerial photography & LiDAR

1P. **Many participants interviewed exploit remote sensing datasets which are not captured by satellite, notably aerial photography (AP) and LiDAR datasets**. Though the scope of this study is focused on satellite based EO, conversations around aerial and drone data were encouraged, to draw out lessons learnt from the way existing aerial datasets are distributed throughout the public sector and potential technology transfer opportunities where EO may offer additional value to AP use cases. These

conversations were predominately in reference to data delivered through the PSGA and APGB agreements.

1Q. In the Local Authorities and Public Services workshop the importance of the APGB imagery in day-to-day operations was highlighted across a range of use cases including detailed urban planning, assessing community safety and monitoring waste sites.

Empowering current AP use

1R. Discussions in the Local Authorities and Public Services workshop led to knowledge sharing between participants, with some finding **novel ways to access datasets which enabled new use-cases**, making a case for improved knowledge sharing around datasets available to the public sector.

1S. Several **organisations could not make use of the APGB data to the same extent as others due to spatial inconsistency of complementary datasets** across the UK, e.g. The limited availability of LiDAR across Scotland was of note.

Complementing AP use cases

1T. Several **use cases currently using aerial photography have the potential to be replaced or integrated with satellite derived EO**. The opportunity of increased temporal frequency was the characteristic of satellite EO that was of the most interest.

1U. For example, during the Welsh Government's trial of smallsat data, they found that making **use of EO imagery data provided a higher temporal cadence, enabling closer monitoring of environmental impacts**.

1V. **An example of use cases transitioning from survey cameras to satellite EO comes from the UKHO where** the imagery captured by survey cameras on HMS Endurance for UKHO overseas mapping was replaced with VHR (Very high-resolution) satellite commercial imagery datasets when HMS Endurance retired. Satellite imagery had a cost benefit over reinvesting in the required survey equipment. However, in the case of UK-EO coverage, preference remains with the aerial imagery captured by the Channel Coast Observatory, as it is freely available.

1W. **An approach to integrating satellite EO into the public sector could be to treat access in a similar way to the APGB imagery to enable wider use**, however concerns over the associated complications were raised by some mature EO organisations.

"The APGB product can work in the way it does because it is a much simpler static layer to produce. Challenges exist such as how would the data be procured, who would manage, make payment and download" (Defra DDTS)

THEME 2: PROCURING COMMERCIAL HIGH-RESOLUTION DATA

Very high-resolution (VHR) satellite data products, developed by commercial operators, have in recent years become increasingly available and affordable. The high resolution and short latency time of these products mean they have the potential to both transform existing use cases for EO data and unlock new use cases in the UK public sector. This section explores the extent to which these products are already in use in the UK public sector, the UK public sector understanding of the value of this data, the challenges encountered so far, and how access and value for money can best be achieved.

2A. **Commercial high-resolution EO data is a critical data source for approximately 30% of operational use cases captured through the study**, primarily associated with a core group of high-maturity organisations (43%). A widely recognised latent demand for access to these datasets exists across the UK public sector, a range of captured use cases would benefit from improved access and increasing number of disparate contracts covering a range of operational, ad-hoc project-based, and exploratory uses (Table 2).

2B. **The study evidences a consistent demand - and captures initial requirements - for further coordination of commercial high-resolution EO data procurement** across the UK public sector. The breadth of experiences captured through the study's stakeholder engagement is presented around key common considerations and challenges that are summarised in the following section, from long-standing to emerging demand, with an additional emphasis on licensing considerations.

Summarising Experiences

Long-standing demand

2C. All departments and organisations procuring high-resolution EO data were found to be addressing explicit requirements in delivering existing or exploring potential use cases. Where an explicit requirement and effective business case has been implemented for procuring commercial high-resolution EO data within higher EO maturity organisations, **several challenges in procurement were consistently captured through our stakeholder engagement**: End User Licensing Agreement (EULA) considerations, ensuring value for money procuring independently, and practicalities of appropriate data sharing.

2D. Sensitivity of requirements across MOD organisations was foreseen as a potential prohibiting factor in a coordinated procurement business case. Whilst **the study confirmed that ensuring protection of security sensitivities is a clear requirement for any coordinated procurement mechanism**, no evidence was found to indicate this being a blocker in practice.

2E. On the contrary, a notable ongoing risk of not having a coordinated procurement mechanism in place - identified in a prior defence report exploring the case for MOD-wide procurement - is **potential exposure of UK foreign policy interests from patterns of requirements being overseen by commercial operators**. Ensuring alignment with existing best practices within MOD would systematically mitigate this risk across UK public sector organisations.

"During a major event, where multiple agencies are interested in a similar area on the ground, if different departments start procuring data of a particular site, it may give commercial organisations a clear insight into UK government strategic interests." (NCGI)

2F. Core MOD requirements are broadly met through a single contract renewed every 3-5 years and international partner capabilities. **There is an acute awareness of maturing private sector capabilities beyond EO imagery data provision** and an increasing desire to become a procurer of higher level EO services to efficiently meet evolving policy requirements.

2G. Where complex and evolving requirements were being met, **procurement through an intermediary was found to be critical to engage the full range of commercial EO data suppliers** to meet requirements.

2H. Lobbying by emerging capability providers - particularly beyond basic EO imagery data provision - is widely recognised as a risk to government capability to consistently act as an informed customer and guarantee value for money.

Maturing demand

2I. In the majority of stakeholder interviews the **primary blocker to adoption of high-resolution commercial EO procurement beyond the core group of high-maturity organisations was identified as actual data cost**.

2J. The Defra group, partially coordinated through the EOCoE, has both an established and explicit demand for high-resolution commercial EO data to meet existing operational policy requirements and is experiencing a rapid acceleration in demand to meet evolving policy requirements. **A key blocker for wider use of data procured under existing contracts is uncertainty of restrictions around licensing agreements and practicalities of data sharing**.

"*Rural Payments Agency (RPA) uses high-res commercial EO imagery to monitor compliance as a requirement under the Common Agricultural Policy. The EU provided this imagery initially, after Brexit procurement responsibility moved to the UK. It has been procured with licensing that enables access across Defra groups, but the interest from other Defra groups has been limited, perhaps given its random localised coverage. The same imagery could be useful elsewhere, i.e. Environment Agency is interested in incident*

response." (Defra EOCoE)"

2K. For some organisations where a maturing demand was identified, **uncertainty around future access is a prohibiting factor** for engaging in trials and considering integration of high-resolution commercial EO within operational remote sensing frameworks.

"Though commercial VHR trials are happening within Defra, the Living England team cannot spend time integrating the data without assurance of future availability. If this was assured then we would likely use high-resolution or very high-resolution data for validation work as a support tool, to clarify where changes have taken place. The Living England model is flexible, ingesting a mixture of datasets would be possible." (Natural England – Living England)

2L. **A range of high-resolution commercial EO data trials are being undertaken across the UK public sector** with significant overlap in suppliers, use cases, technical approaches, and geographic coverage of operational scope.

2M. **The lack of efficient mechanisms for sharing of experiences beyond organisations and departments, and limited access to outputs from procurement trials, is a major prohibitor** for translating exploratory use cases into operational processes within emerging and maturing organisations.

2N. While some specific challenges for coordinated procurement were identified relative to other central procurement mechanisms (i.e. PSGA), it is clear from the maturity of other UK public sector EO capabilities, where dynamic streaming of multi-temporal open EO images are delivered, that these can be readily addressed (i.e. EODS).

"Whilst government wide procurement may seem good on paper the practicalities are challenging. Aerial photography provision works in this way, but this is a much simpler, static layer to produce. Challenges include how data procured would be managed, such as payment on download, etc." (Defra EOCoE)

2O. **Improving visibility of and access to existing data was suggested as an intervention** that a coordinating entity could make to support current UK public sector demand.

"It should at least be possible for each organisation to procure their own commercial imagery, then make it available to others, but challenges are likely to be faced." (Defra EOCoE)

2P. Data quality consistently arose as a consideration, particularly for high-cadence, high-resolution data from smallsats. **There were no cases identified of organisations procuring the higher-level EO imagery data products** that have appeared more recently across the EO Data Market and potentially address both data

quality and uncertainty considerations, but also support broader integration into the wider UK public sector geospatial ecosystem.

"On the whole, the data quality was poorer from smallsats than larger satellites, but the frequency is key." (JNCC)

2Q. FCDO is one of the most rapidly developing users of commercial EO data, with application primarily driven by demand from country offices to address humanitarian use cases, for example through the FCDO-ONS data science campus and larger procurement frameworks. Whilst largely ad-hoc and project based to react to developing overseas objectives, **a wealth of innovative use cases could be transferred across other areas of the UK public sector that require overseas data coverage.**

Emerging & Undefined Demand

2R. **Establishing the business case for procurement on a per-organisation basis was found as a key blocker for meeting emerging policy demands**, due to challenges in efficiently defining costs, understanding the art of the possible, procuring data in practice, how to articulate value for money within business cases, and, perhaps most crucially, building a specification that accounts for the broad spectrum of requirements.

2S. **Significant emerging and evolving demand for commercial high-resolution EO exists** within future agricultural systems and environmental land management schemes, achieving Net Zero, national climate reporting, and sustainable finance.

"There is a clear need to understand how VHR aligns with future schemes." (Welsh Government)

2T. There is a clear **gap between current and potential commercial EO data capabilities for use cases** currently being explored.

2U. Examples of **critical sensor technologies for delivering against emerging policy demands** include **GHG (greenhouse gas) monitoring** capabilities, **hyperspectral** (greater spectral sensitivity) and **value-added products** and services available through the EO services market. The most mature of these is high-cadence, high-resolution optical imagery data, that is being actively explored in a disparate manner across organisations and departments.

2V. **Addressing the immediate need for improved coordination in meeting current demand** for high resolution optical EO data would allow the UK public sector to focus on realising the benefits from these maturing EO capabilities.

High-Resolution Commercial EO Data Contracts

2W. **The study identified active contracts where organisations were directly procuring commercial EO data** to support both operational and exploratory (R&D) use cases. Whilst not an exhaustive list, table 2 sets out what we consider representative of the variation of such contracts across the UK public sector.

Organisation(s)	Supporting Requirements	Dataset Characterisation	Routine Operational / Project-based / Exploratory
Defra – Rural Payments Agency	Compliance, control with remote sensing.	Relevant very high-resolution EO data.	Routine Operational
Ministry of Defence (MOD) – Defence Geographic Centre, National Centre for Geospatial Intelligence	Intelligence from foundational geospatial data. Intelligence sharing and operational planning beyond restricted communities. Complementing state owned / operated capabilities. Foundation mapping & charting.	Nominally state-of-the-art spatial resolutions (rarely less granular than 50 cm). 3-year contract via broker.	Routine Operational
MOD - UK Hydrographic Office	Foundational mapping & charting.	Linked to other MOD contracts, data sharing agreements (50cm and higher resolutions). Limited gap filling via smaller independent contracts.	Routine Operational
Welsh Government - Natural Resources Wales, JNCC, Forest Research, UK Centre for Ecology and Hydrology, Welsh Water	A broad range with evaluation largely driven by Living Wales.	12-month pilot. Access (50cm data, small sat tasking.	Exploratory Operational Trial pending
Foreign, Commonwealth & Development Office	Humanitarian and development intelligence gathering.	Nominally state-of-the-art spatial resolutions (mostly 50cm spatial resolution and higher)	Project-based / Exploratory
Scottish Government – Historic Environment Scotland	Archaeological site detection, condition monitoring & macro-scale change detection.	High resolution smallsat data via ESA collaboration (third party missions)	Exploratory
Defra - Environment Agency	Agricultural regulation	High resolution smallsat data.	Project-based

Table 2. Summary of identified commercial high-resolution EO data contracts.

Licensing Considerations

2X. **Ensuring suitability of End User Licence Agreements (EULAs) is a challenge identified by almost all stakeholders interviewed** in procuring commercial EO data. Each of the example contracts captured in the study relied upon separate reviews of their suitability against use case requirements and government legal and procurement policies. There was a consistent pattern of organisations not negotiating terms offered by suppliers, due to only spending small amounts, limiting the potential to share data, and impacted negatively on the value of the insight for a use case.

2Y. One of the **single most significant drivers for coordinated procurement of commercial EO data across the UK public sector is the opportunity to agree optimal licensing terms for the UK public sector. To ensure existing best practice**

(e.g. PSGA terms) are drawn on and to encourage onward sharing of the data. The key characteristics encountered include:

i. **Perpetual term**: It is becoming increasingly common for data providers to offer non-perpetual (i.e. annual / subscription-based) licensing as default.

ii. **Data sharing**: Even for highly informed and better coordinated procurers, understanding the precise extent to which it is possible to share data is challenging. Confidence with EULA interpretation and practically drawing a line on who falls within 'internal' user categories are two areas that would benefit from clarity and consistency of legal interpretation with significant potential to mitigate current and future data silos.

iii. **Regulatory use cases**: Organisations were found to have very different experiences in using commercial high-resolution EO within legal proceedings and processes (i.e. civil prosecutions). In existing operational use cases this is the core rationale for use (i.e. MOD), however in some exploratory use cases (i.e. Welsh Government smallsat data trials) this was found to be prohibitive. From a data provider perspective, this should not be an issue in practice, and is a potential low-hanging fruit opportunity for improving clarity in procurement across UK public sector organisations.

iv. **Export control**: EULA terms relating to export control are becoming increasingly complex across data providers. While not considered a challenge in practice by some mature users, an increasing number of organisations working overseas (i.e. FCDO) are encountering ambiguity around the boundaries of their responsibilities and identifying appropriate stakeholders for signature.

General Licensing Messages

"There is a limitation with licensing of commercial data within Natural England and Defra, from a legal standpoint, legal teams make it difficult to agree on the terms and conditions, and projects run out of time before this is resolved, which becomes a project risk." (Natural England).

"VHR is considered to be both a licencing and cost minefield" (Environment Agency)

"Defra has lots of analysts, but a small licensing team, a challenge when needing to monitor dynamic licensing." (Defra DDTS)

"Some EULAs are very complicated and change over time. It can be difficult for organisations to negotiate appropriate changes to these, particularly when only spending a moderate amount (i.e., £10,000). A central agreement from HMG would make things far simpler, and a step toward a EULA similar to the U.S Government's NextView License." (UKHO)

Perpetual Licensing:

"With VHR a significant input of time is needed to ensure there is clarity on licensing conditions, e.g. does data have to be deleted at the end of the trail; can derived products be kept, what are the publishing rights etc. Time is well invested in getting this right and understood. Clearer licensing will increase understanding and confidence and therefore likely to increase use." (Welsh Government)

Data Sharing:

"In terms of licensing arrangements, MOD require an alternative option to defence only licenses, but this can get challenging." (NCGI)

"A Defra-wide license exists for many VHR data procured within the Defra group, but expansion beyond this, even to wider arms lengths bodies is complicated" (JNCC).

"There is an element from suppliers of not understanding how large Defra is, which can make getting a Defra wide license difficult." (Defra EOCoE)

Regulatory

"Discussions are ongoing with commercial providers about whether imagery can be used in legal proceedings and whether they would be less cautious for civil proceedings (e.g., landfill tax audit) rather than criminal." (NRW)

"NCGI (National Centre for Geographic Intelligence) does contribute to criminal investigations conducted by other government agencies which can result in legal proceedings, so that data neds to be CSI (Commercial Satellite Imagery) as opposed to classified." (NCGI)

Export control:

"CSI gives us (MOD) the ability to share data beyond the 5 Eyes intelligence community or NATO, including public release when necessary. If intelligence or data is to be provided to another country steps need to be taken to provide assurance that it will not be used to cause harm or to undermine UK national interest. What is shared is almost always a derived image or intelligence product, not raw data. (NCGI)

THEME 3: UNDERSTANDING & ENGAGING INDUSTRY

In sectors where technological capability is accelerating quickly, it is useful for the UK public sector to maintain a strong understanding of the industry and its developments, so that it may best take advantage of the efficiencies and insights new technology enables. Satellite and EO technology are one such industry. This section explores the UK public sector's existing understanding of and links with the commercial satellite industry and technological developments, and how this impacts its capacity to understand the 'art of the possible' and innovate new policy solutions.

3A. **Effective working with industry suppliers is identified as a key strength of organisations across the spectrum of EO maturity.83 industry partnerships were captured** across **use cases.**

3B. **Establishment of the CCS Space & Geospatial Dynamic Purchasing System will** enable easier procurement of geospatial data services, including for EO data. All **stakeholders interviewed showed an acute awareness of the challenges** impeding the adoption of evolving industry capabilities across both the EO data and - increasingly - EO services markets.

3C. **The study encountered significant demand for a more coherent approach across the UK public sector to support improved awareness, understanding, and evaluation of the products and capabilities available in the EO data and services markets.**

3D. Engagement with commercial services can be seen across use cases of almost all UK public sector organisations explored in the study. The study found **clear recognition of the importance of utilising commercial capability to improve efficiency** in delivery of UK public sector services.

"EO is about integration of satellites and in-situ; public and private platforms; and novel EO systems. Partnerships and data sharing are critical, particularly for moving from exploitation of essential climate variables to more bespoke application climate variables." (Met Office)

3E. **Industry engagement was largely limited to the delivery of operational use cases in some organisations.** Cost effectiveness was the main driver in mature EO organisations' preference to undertake exploratory and R&D use cases internally.

"Testing of commercial EO data and service markets is done solely to meet internal operational requirements, the initial exploration of technical feasibility typically happens internally." (RPA)

3F. **Consideration and adoption of industry capabilities within the most mature EO user organisations is most often for data coverage.** Exploration of market developments through initiatives such as broader governing and partnership

structures was recognised as offering greater stability and increased leverage in discussions with emerging industry partners around operational EO uses.

"Partnership with industry and adoption of commercial EO datasets and their evolving disruptive business models is less pertinent at a national level for numerical weather prediction and climate due to policy and governing structures remaining at a European and international level; tension sits within these international communities' forums." - (Met Office)

3G. A downside to reliance on inflexible procurement mechanisms is the reduced agility necessary for productivity gains to be tested and adopted.

"Integrated into the five eyes partnership is a lot of senior level engagement with vendors at a strategic level. This is positive and there is potential to the offerings, but, because of rigid frameworks, it's difficult to exploit." (NCGI)

3H. The delivery of future agricultural systems, away from the Common Agricultural Policy post-EU exit, highlights some of the benefits and drawbacks of engaging industry outside of international governance structures. There is a widely recognised opportunity for an expanded role of EO, necessitating greater industry involvement. While there is the potential for greater innovation, maintaining awareness of lessons learnt from broader European evolution will be critical.

"The movement from CAP towards ELM (Environmental Land Management) brings challenges along with a fresh value proposition for EO, i.e., monthly cadences are to be considered for VHR imagery. A POC was recently undertaken to explore the possibilities of using time series VHR imagery to support ELM monitoring." (RPA)

3I. Less evidence was found than anticipated regarding UK public sector organisations undertaking internal exploration of burgeoning private sector capabilities. **There was little evidence of adoption of commercial sensing capabilities thought to be critical for delivering against emerging policy requirements**, e.g., GHG sensing capabilities, small sat SAR constellations, and 'high resolution' hyperspectral imagers.

"We should be able to get to a stage where HMG is an early adopter, efficiently exploring emerging capabilities and positioning policy, culture, and skills for adoption" (Environment Agency)

3J. There is an **accelerating demand for increased adoption of higher-level EO products and services** available across the EO services market, however the long-standing challenges around commercial high-resolution EO data procurement are exacerbated by the variety, quality, and rate of change of services offered.

"The EO data market and intelligent procurement of services are challenging, as they are changing quickly, it is also hard to keep ensuring the user is getting value for money." (JNCC)

3K. **Lack of resource capacity** was the most commonly identified and significant prohibiting factor to evaluating the potential for new EO technologies within individual organisations and departments.

3L. Evidence of how UK public sector organisations 'stay in the loop' with developing industry EO capabilities varied across the study. Outside of service procurement, the study found engagement mechanisms to be exclusively informal and industry driven. However, **maintaining an understanding of industry capability was repeatedly identified as a significant challenge** and blockers to adoption of EO across the full spectrum of organisations.

"It's recognised that from data providers, markets are constantly changing, there is not a single solution, different companies are more aggressive in lobbying the government - this can make it difficult to decide on the right provider for a longer-term contract." (Defra EOCoE)

3M. **Building sufficient confidence and trust in the level of transparency typically offered by industry providers** can be difficult across all the organisations the study engaged.

"A barrier, with the boom of the services market off the back of the data market, is that potential users are overwhelmed. Services are not transparent, and target specific users, but not expert users, so they aren't making informed decisions and don't know what to do with the information." (JNCC)

"Commercial providers (as an alternative to our Earth Observation Data Service (EODS)) have been considered, but often as a black box. There are multiple ways to process the data and different departments have different processing requirements, so they need flexibility and knowledge" (Defra EOCoE).

"For Several years we (NCGI) have been discussing buying the results of analysis rather than pixels. However, there is recognition that when buying the results, we don't have ownership over the end-to-end process, which means we are unable to fully assure the validity of the analysis. This may be acceptable in some cases, but it limits the extent to which the intelligence can be acted upon. (NCGI)

3N. As the UK public sector geospatial ecosystem becomes increasingly integrated into dynamic 'system of systems' services, **managing uncertainty across data products is recognised as critical for policy delivery**. Some UK public sector services are champions in this area. Articulating requirements to manage/increase transparency around uncertainty through future tenders is a clear opportunity for holding 'black box' solutions to account.

"Information regarding uncertainty is provided with the different environmental descriptors (e.g. canopy cover, biomass) used to construct the land cover maps generated for Wales by Living Wales, with this informing decisions relevant to policy and land management" (Welsh Government - Living Wales).

3O. In highly EO mature organisations the **transition to procurement of results or 'insights' rather than pixels will require additional protocols** to ensure no loss of reliability when interpreting derived intelligence.

3P. **In some areas it is currently not appropriate for the private sector to play a role** in delivering mature and well-established services due to security sensitivities.

3Q. Supporting these organisations in engaging with commercial suppliers requires the UK public sector to build upon previous government experiences of deciding when services offer value for money.

"In 2016 Defra put out a tender for a national habitat map, the responses from industry were too expensive. As a result EOCoE funded a pilot project, the product was an 83% cost saving compared to industry, this later became Living England." (Natural England)

3R. **The UK public sector is currently lacking a coordinating presence for EO industry engagement** and collation of requirements. Mitigating the risks of lobbying by particular vendors and informed exploration and evaluation of cross-cutting capabilities are clear areas for improvement.

"*There isn't a place for market research within EOCoE. Lots of stakeholders require this, but there is no official mechanism to do it." (JNCC)*

THEME 4: SKILLS, TRAINING & KNOWLEDGE EXCHANGE

While the first three themes consider how the UK public sector understands and interacts with external EO communities and suppliers, this section focuses inward on the processes and engagement within and between UK public sector organisations. The value of data only extends as far as the understanding of those who use it. If its full value is to be realised, access to satellite data must be complemented by internal expertise to manage and apply the data correctly to meet policy aims. Existing expertise can be shared with other organisations to optimise their own operations.

4A. **Awareness and understanding of EO activities, capabilities, business cases and stakeholders across the UK public sector was consistently identified as an area for improvement and a notable barrier for maximising the potential return on investment from UK investment in EO.**

4B. Key findings focus on **how to unlock value** (knowing how to derive insights from the data and engage with enabling technologies) and **sharing insights** (eliminating replication of contracts and use cases across gov, building cross-gov understanding, etc.).

Unlocking Value

4C. **To realise the full benefits from EO, users need to be well informed on the potential, best practice, and implications of the data.** In a recent data trial of smallsat imagery:

"Departments with specialists saw the most benefit, whilst those without skilled analysts didn't experience the direct benefits as much and needed technical support."
(Welsh Government)

4D. **Dedicated activities across the international EO landscape are lowering the barriers to entry for non-experts to derive insights from EO data**, such as provision of analysis ready data. However, concern was expressed in several interviews around correct interpretation of the data, and the dangers associated with misidentification and mis categorisation of the data, particularly when it came to SAR data. These concerns were expressed by the MOD where precision and accuracy are of high importance and extend to wider concerns of data quality related to both imagery and derived insights.

4E. Many government departments have specific GIS or EO teams, though these are typically small in relation to the value delivered and often stretched due to the large remits covered. **Resource capacity was highlighted as one of the greatest challenges** for many organisations interviewed as well as in the Local Authority and Public Services workshop. It is exemplified by Natural Resources Wales (NRW), which, despite their large operational remit for EO, has only a few fulltime Remote Sensing Specialists.

4F. NRW also echoed other stakeholders' **challenging experiences in hiring specialists with the appropriate skills**, particularly within the constraints of civil service employment structures.

4G. While resourcing challenges necessitate a highly efficient and prioritised approach to adopting EO within NRW – with a focus on enabling access to a self-service suite of tools – this is believed to stifle the total potential value from EO.

4H. Resourcing has also been a challenge within Natural England:

"A challenge was resource in Natural England, historically there hadn't been EO teams, a case had to be made to make this a priority and find space in the budget to bring in the appropriate resources." (Natural England).

4I. **The COVID pandemic has accelerated the increase in demand for EO within organisations**, for example, with reduced accessibility for field visits. In response, organisations such as NRW have upped their training and webinars.

4J. In several interviews it was noted that often **departments or organisations knew of potential EO opportunities but lacked the time or budget for innovation** or to develop the business case.

'Organisations that might have the most to benefit from developing the use of EO are often those with the most pressure on their resources, so unable to invest into exploiting the potential of EO.' (Welsh Government)

4K. As the breadth of demand for EO increases across the UK public sector there is a clear gap to be filled in mitigating the **duplication of effort in repeating these common early-stage experiences** across departments and organisations.

4L. **A lowered skills barrier to entry and reduction in duplication of experiences was considered essential for supporting a 'system of systems' approach** for realising disparate EO value propositions.

4M. While outside the focus of the current study, a desire for closer working relationships across different types of non-commercial UK organisations was expressed throughout our stakeholder engagement. It is thought that a **closer alignment of research and innovation centres objectives within a clear UK public sector EO framework** will accelerate the unlocking of future value propositions and support a holistic, thematic-led approach to innovation.

Sharing Insights

4N. Across the stakeholder engagements **there was a desire for improved knowledge-sharing in common areas**:

i. Development of business cases

ii. Data and products

iii. Use cases and technical feasibility

iv. Navigating imagery contracts

4O. Some **organisations recognise their relative maturity and the value this could bring to others**. An example of this is the UK Hydrographic Office who are leading work with bathymetry are wanting to share the outputs with others to ensure other interested parties are informed users. As there is a mixture of EO maturity across civil and defence departments, explicit intervention to enable findings to be shared would make clear progress against the objective of greater civil-defence integration within the National Space Strategy[7].

4P. In several interviews and in the Local Authorities and Public Services Workshop, the existing **inefficiencies linked to the informal nature of knowledge sharing between departments was highlighted**. During the Local Authorities and Public Services Workshop imagery challenges were discussed, of which others in the room offered solutions, demonstrating that the knowledge exists, but currently it is difficult to access between organisations.

4Q. An example of **a successful sharing opportunity was the evolution of Living Maps, a joint EOCoE and Natural England feasibility project for broad-scale habitat mapping**. Though originally a discretely funded project, the code was shared on GitHub and picked up by JNCC to map overseas territories. This project has since evolved into Living England, an operational version of Living Maps, with multiple workshops to encourage understanding of the method.

"The resilience of projects will not survive and evolve without handing the technical knowledge to a wider group of technical specialists" (Natural England)

4R. An interview with UKHSA, a new organisation, and other immature EO user organisations expressed a strong desire for a centralised EO framework to support development of systems.

"It would be good to have EO data and evaluation frameworks, with a clear steer on the most

[7] HM Government (2021) National Space Strategy

appropriate way to integrate EO into other technological systems." (UKHSA).

4S. The sense that services across departments could build on each other with better communication was clear throughout the interviews, an example being the UKHSA's desire to build a mosquito risk map based on the EA flood mapping product. **Some departments, notably the FCDO, found knowledge regarding EO data was siloed even within a department**.

"The implementation of satellite imagery across the FCDO is fragmented by the organisation's structure. This is a key barrier to the successful exploitation of EO data as the current business model and imagery licensing is designed to funnel data into silos and make it difficult to access and reuse for other applications" (FCDO-ONS Data Science Campus)

"There is no doubt that a more flexible, cross-government approach to EO data would open up additional use cases on statistics, climate, food security and disaster response that are not currently being implemented." (FCDO-ONS Data Science Campus)

4T. Along with sharing technology, the **complexity around formulating EO business cases was expressed as a challenge** for less mature organisations and suggested as something which could be shared between organisations, though recognising financial sensitivities.

"Being relatively 'new', availability of a framework that looks beyond the technical and toward business case creation and policy drivers would be very helpful in realising benefit from EO." (UKHSA)

4U. There are multiple examples of cross UK public sector working groups around the use of Earth Observation. Despite their varying levels of longevity and EO maturity levels, all of these were held in high regard for inclusivity beyond their core remit. Notably but not exhaustively:

i. Defra **Earth Observation Centre of Excellence (EOCoE)**. The EOCoE is held in high regard as an EO facilitator across UK public sector organisations covering environmental reporting and other relevant policy areas; in the EOCoE interview they expressed their role as more about requirement gathering and connecting over 'the doing'. A recent example is supporting a workshop around the cross-departmental opportunity for EO within NetZero, to identify gaps, opportunities and in progress work.

ii. **Scottish Remote Sensing Group (SRSG)**. The SRSG looks to promote best practice and collaboration to drive innovation and improve the delivery of required public services that draw on remote sensed data. The group engages with industry and research centres. They also provide governance for the Scottish Remote Sensing Portal, a collection of remote sensed data provided by Scottish Public Sector Organisations.

iii. **Northern Ireland EO Steering Group (NI-EOSG)**. NI-EOSG brings together expertise from across the Northern Ireland (NI) public sector to provide strategic

direction to increase the awareness of, enable access to, and accelerate the use of, Earth Observation (EO) data, services and applications across NI.

4V. One recent initiative is the emerging Data Hub and Data Programme within the EOCoE for Data Science, a group of organisations with environmental remits between departments, beyond that of just Defra coming together around the technology. This represents a transition to more generic data science capabilities and lends itself to the increasing desire for broader integration of EO within generic policy data science problem spaces.

4W. **None of the stakeholders the study engaged were aware of any single-point-of-access** for shared inter-organisational technical, business and policy experiences across government.

4X. Two relatively recent and formal cross government knowledge sharing mechanisms identified as offering high-potential impacts were the introduction of the No. 10 Innovation Fellows and the recognition of the importance of geography across Government through the creation of the Government Geography Profession, although these don't focus on EO specifically, in some cases EO is the focus. For example the FCDO, No. 10 Innovation Fellows have been reviewing the use cases of EO in humanitarian/overseas development projects and the training needs across the organisation. The Geography Profession is promoting best practice use of Geography and the associated data and analysis capabilities throughout all of Government and will provide a suitable channel for helping to promote EO capabilities and expertise beyond the traditionally niche specialisms of individual organisations.

SECTION THREE: OPPORTUNITIES & RECOMMENDATIONS

SUMMARY

Based on the findings explored in the previous sections, this report proposes three opportunity areas and high-level recommendations. These are identified as the most significant opportunities to unlock value based on this study's understanding of demand and feasibility to deliver within the UK public sector. The opportunity areas and high-level recommendations are not for any one specific department or organisation. They are proposed as clear opportunities, based on a strong evidence base, to strengthen and broaden the UK public sector EO user community as a whole and enable more efficient and effective delivery of government policy priorities.

Current Study		**UK Geospatial Strategy Missions[8]**			
Opportunity Area	**Recommendation**	**Mission 1:** Promote & Safeguard the use of location data	**Mission 2:** Improve access to better location data	**Mission 3:** Enhance, capabilities, skills & awareness	**Mission 4:** Enable Innovation
A: Evolve existing EO open data services	1. Explore how current services providing access to open EO data can evolve and be positioned to efficiently meet growing demand.	*Critical open EO data more widely available in a more usable format.*		*Foundations established for advanced EO analytical capabilities.*	*Open data sets can support emerging policy requirements.*
B: Coordinating procurement of commercial high-resolution EO data.	2: Assess the investment case for a coordinated procurement mechanism for commercial EO data to meet current and emerging policy requirements.	*Engagement across HMG-wide requirements for EO.*	*Removal of the most significant blockers to EO data access and sharing across the UK public sector, e.g., licensing.*	*Reduced duplication of resource required for procurement and, in some cases, in-house processing of data.*	*Emerging policy areas can consolidate requirements and 'piggy-back' on mature EO data procurement.*
C: **Promote EO expertise and knowledge sharing**	3: Enhance knowledge sharing and collaboration between UK public sector bodies to encourage greater uptake of data amongst those organisations with a lesser and moderate EO maturity.	*Engagement across HMG-wide requirements for EO.*	*Helping UK public sector bodies to build capability and access by sharing information on use cases and investment cases.*		*Emerging policy areas (e.g., Net Zero) can build upon established and more accessible business cases.*

Table 4. *Summary of opportunities, recommended interventions, and their relevance to UK Geospatial Strategy Missions.*

[8] Geospatial Commission (2020) Enhancing the UK's Geospatial Ecosystem.

OPPORTUNITY AREA A: EVOLVE EXISTING EO OPEN DATA SERVICES

Recommendation One

Explore how current UK public sector EO data services can evolve and be positioned to efficiently meet growing demand.

Desired Outcome

The introduction of EO data services has significantly reduced the barriers to the use of openly available EO data for UK public sector bodies that access them (e.g., EO data from the Copernicus Programme). Where data services have been established (particularly those that process raw data to analysis-ready data (ARD) e.g., Defra EO Data Service (EODS)), there are opportunities for further evolution and standardisation of the services across organisations and opportunities to unlock increased value. Insights from UK public sector users suggest that tackling this opportunity area would improve efficiencies across existing EO use cases, accelerate innovation across emerging and potential policy demands, reduce overheads from duplicate services, and ensure maximum value for money is derived. Maximising service adoption and ensuring the services provided can meet the demand of UK public sector users will empower organisations to efficiently integrate EO data and derived products into policymaking.

Without intervention, the UK public sector may miss opportunities to:

- Encourage greater uptake of existing services for open EO data.
- Avoid duplication of budget and resource allocation on data provision and management.

"The business case for the EODS is primarily to embed EO into day-to-day business" (Defra EOCoE)

"Ideally, the optimal approach to ARD production is at the UK level to avoid duplication of efforts." (Scottish Government)

Context

The UK has a mature, well-established, yet disparate EO data infrastructure landscape, including sustained investment in support of UK public sector adoption - particularly for open EO data sets (specifically EODS and SARD which draw on Copernicus Sentinel data). To date, **demand-driven investment in public sector EO infrastructure in the UK has aimed to provide more efficient and consistent access** to openly available EO data to address day-to-day business requirements, whilst also mitigating duplicate processing

efforts (1B-F).

- **A clear demand exists for the consolidation of existing EO data service investments across the UK** (1E-G), however, re-evaluation of the positioning of these services is needed against ongoing developments across the private sector.

- Existing use cases that are not currently using UK public sector EO open data services could be better supported if **gaps identified in existing services were considered within the evaluation of their current ecosystem positioning** (1I).

- **Consideration of the case for further investment in these services would require greater industry engagement**, not only to ensure efficiencies in the data services but also to maximise the sustainability of the service in addressing higher-level EO product requirements demanded by maturing and emerging policy areas such as the transition to Net Zero, climate reporting obligations, green finance (1J).

- **Current organisations and initiatives responsible for championing a more coordinated approach to-date have not implemented a holistic, UK public sector-wide thematic approach** for collating requirements due to funding and resource restrictions. Establishing the case for investment should benefit from the evidence base gathered.

OPPORTUNITY AREA B: COORDINATING PROCUREMENT OF COMMERCIAL HIGH-RESOLUTION EARTH OBSERVATION DATA

Recommendation Two

Assess the investment case for a coordinated procurement mechanism for commercial EO data to meet current and emerging policy requirements.

Desired Outcome

There is established demand in the UK public sector today for very high-resolution commercial EO data. In several cases, this data is already under operational use, and in others in the processing of being piloted. Broader engagement with this data across the UK public sector is likely to result in increased efficiency in existing EO use cases, and new insights to inform emerging use cases. However, there are significant barriers to broader adoption, including market understanding, licensing considerations, and availability of in-house skills and expertise to both procure and then use the data. Furthermore, there is already a risk of siloed duplicated procurement, where different organisations are purchasing the same or similar products, creating market spending, resource, and skill inefficiencies. The UK public sector should consider mechanisms to ensure that it is aware of the opportunity and realises the best value for money in its procurement and use of this data. This will also allow effective data acquisition, effective use of many of the emerging commercial EO missions and potentially identifying where investment into UK sovereign missions' capability is required to fill existing data gaps.

Without intervention, the UK public sector may miss opportunities to:

- Benefit from value for money, as datasets often offer better value when purchased in larger quantities, while avoiding duplicated procurement.
- Share datasets more widely where this is currently limited due to lack of licensing clarity.

62 of the use cases captured could immediately benefit from greater coordination in procurement

"During a major event, where multiple agencies are interested in a similar area on the ground, if different departments start procuring data of a particular site, it may give commercial organisations a clear insight into UK gov. strategic interests." (NCGI)

"It should at least be possible for each organisation to procure their own commercial imagery, then make it available to others" (Defra EOCoE)

Context

- The narrowest definition of value for money in procuring high-resolution EO would be to **ensure HMG as a whole is paying the lowest possible price per unit area** for access to data to fulfil an explicit set of requirements.

- Despite some individual departments and/or organisations being informed procurers against explicit requirements for operational use cases (0B,2A-Q), **if requirements were collated and an overall tender released to EO data providers, HMG would pay a lower price per unit area overall**, obtaining greater value for money (2I,R).

- **Value for money to HMG must also consider agreement of licensing terms.** Negotiation of licensing terms suitable for appropriate sharing between UK public sector organisations and with external contractors and for use in regulatory enforcement was found to be critical to meeting current and near-term operational requirements (2C,J,X-F,R) and mitigating the current potential for duplicative procurement (2L-M,V,W).

- It was widely recognised by stakeholders as critical that, as the EO data marketplace evolves (2T-V,3A,B) and principles for contemporary geospatial data management mature, any **central procurement of commercial EO data must also consider the technical practicalities of cross-public-sector data management and access**; i.e. data obtained from sources and in formats that allow flexibility in each organisations' data custodian roles (and necessary sensitivities), at the same time as maximising accessibility to internal and external stakeholders, where possible (2O).

- UK ownership/operation of additional EO assets could be a cost-effective means for improving access to certain capabilities and is recognised as a negotiating strategy that several operators are engaged in across HMG. **Acting on the above recommendations would offer a significantly more robust and defensible position that might be championed by the Commission or other stakeholders** through these discussions across other departments.

OPPORTUNITY AREA C: PROMOTE EO EXPERTISE AND KNOWLEDGE SHARING

Recommendation Three

Enhance knowledge sharing and collaboration between UK public sector bodies to encourage greater uptake of data amongst those organisations with a lesser and moderate EO maturity.

Desired Outcome

Improving the exchange of expertise and insight across the UK public sector is one of the most cost-efficient means of strengthening overall public sector understanding and use of EO data. Several groups already exist to this end and are very successful in their promotion of knowledge sharing. To build on this success, further collaboration can be pursued within and between these groups, raising awareness more widely of the potential of access to open and commercial EO data, and the variety and maturity of use cases across the public sector. Collaboration and alignment with technology, research, and innovation activities (e.g., Catapults, KTN, Research Councils) should also be sought. Taking such a targeted approach would help the UK public sector reduce duplication of use cases and spending across organisations, support investment, and drive faster and more efficient delivery of policy priorities, particularly in priority emerging policy areas such as Net Zero and Levelling Up.

Without intervention, the UK public sector may miss opportunities to:

- Share information between departments, particularly with new and emerging policy areas, resulting in siloed data and experience.

90 public sector organisations are envisaged to benefit from a cross-government source for EO use cases, technical feasibility, and prior business cases.

"It would be good to have data and evaluation frameworks from an EO perspective, with a clear steer on the most appropriate way to integrate EO into other technological systems." (UKHSA).

Context

- Some individual **UK public sector organisations are routinely and robustly evaluating the rapidly evolving EO data and services market** through discrete procurement of products and services to meet changing operational requirements (2W).

- Significant demand was found for **improved sharing of lessons learnt from these market engagement experiences** from groups across the full spectrum of EO maturity (4N-T), and an eagerness to support a formal mechanism for improved sharing (4P, 4S).

- **Initiatives such as Defra EOCoE are held in the highest regard** as internal support mechanisms for knowledge sharing, increasingly beyond their core attendees (4U). However, the reliance on informal relationships and department-specific mandates restricts the ability to deliver knowledge sharing across the whole UK public sector.

- **Understanding the technical feasibility of EO use cases is usually the first step in considering EO** for lower maturity groups, however, this did not emerge as the most significant barrier to adoption. Aligning capabilities with policy drivers and establishing the business case were identified as more significant challenges (4T). Improving **access to lessons learnt from previous business cases** for operational use of EO should enable organisations and departments to treat EO as “just another data source” (4T).

- **Most mature users of EO are highly aware of the speed of developments across the private sector (3J, 3L, 4B)**. As higher-level services continue to mature and come to market, knowledge sharing of experiences in engaging industry will become increasingly important to mitigate opportunity costs from prior investment. Evaluating pricing, quality, managing uncertainty, and other characteristics of maturing market capabilities on a 1-1 basis was repeatedly flagged as a current source of friction.

BEYOND THE PRESENT STUDY

Satellite Applications Catapult and the Geospatial Commission will continue to extract insights from the use case data captured through this process to support their respective activities beyond the current study. Where future insights are derived from additional attribution or non-sensitive use cases, these should be shared on a best-efforts basis and when considered mutually beneficial. In the case of a third-party UK public sector group or organisation wishing to further develop the evidence base of potential use cases, both Catapult and the Commission should endeavour to appropriately support these activities.

A clear framework for potential collaboration between UK public sector and research and innovation centre entities is outlined through the study opportunities and recommendations. This framework remains constrained by the evidence and findings of the current study; however, **this is envisaged to foster an ambitious agenda for the Commission and other UK public sector actors'** future activities.