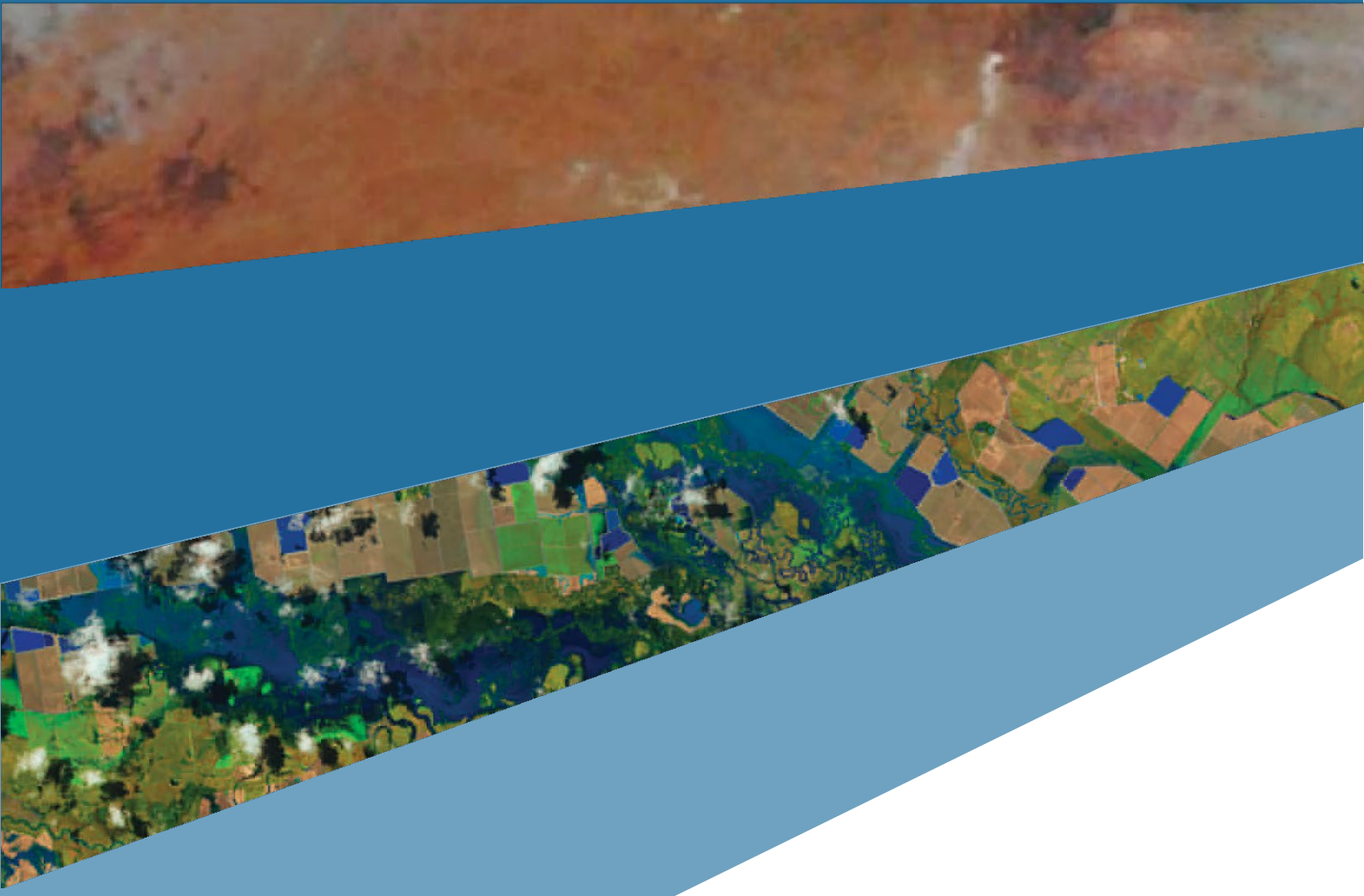

Continuity of Earth Observation Data for Australia: Risks

March 2024

The University of Queensland
AUSTRALIA

Symbios

EOA | Earth Observation Australia Inc

Continuity of Earth Observation Data for Australia: Risks

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This is an independent report prepared by Symbios, The University of Queensland, and Earth Observation Australia Inc requested by Geoscience Australia.

Symbios is a company with over 30 years of experience providing support to governments and industries worldwide in the development and implementation of successful national Earth observation (EO) programs. Our expertise lies in undertaking program management, market and feasibility studies, and policy support, including national program strategy and benchmarking. We have a strong focus on international collaborations and are actively involved in the international coordination processes behind Earth observation, working closely with organisations such as Group on Earth Observations (GEO) and Committee on Earth Observation Satellites (CEOS).

Earth Observation Australia Inc (EOA) is a not-for-profit association serving and representing the Australian Earth observation community. That community includes individuals and organisations in research and education, government, defence, industry, and non-government sectors. EOA enables the Earth observation community to connect, learn, and collaborate to grow and improve EO capability, activity, and services for the future. Our vision is "By 2026, the Australian Earth observation sector will develop and deliver high-quality Earth observation information, infrastructure, and services that are used widely by government, industry, research and the community in Australia and internationally." EOA operated from the School of the Environment, The University of Queensland, 2016 to 2023.

The authors of this report acknowledge the traditional owners and custodians of Country throughout Australia and acknowledge their continuing connection to land, waters, and community. We pay our respects to the people, the cultures, and the elders past and present.

How to Cite This Report

To reference this report in your work, please use the following citation format:

Symbios, The University of Queensland, & Earth Observation Australia Inc (2024). *Continuity of Earth Observation Data for Australia: Risks*.

Executive Brief

- Earth observations (EO) from space play a key role in Australian society, supporting industry, research, and the delivery of government services across many portfolios including weather forecasting, climate, agriculture, natural resources, infrastructure, environmental monitoring, mapping, and defence.
- The satellites that provide EO from space can be considered as critical infrastructure because they provide services supporting the social and economic wellbeing of the nation and Australia's ability to ensure national security (Australian Government Department of Home Affairs, 2023).
- An economic study by Deloitte in 2021 found that EO is economically significant, directly contributing $283 million to the Australian economy in 2020, and underpinning over $2.5 billion of economic activity annually (0.2% of Australian GDP).
- Australia has 171 government programs reliant on EO, 93% of which have a medium to high dependency on EO data.
- The high availability of free and open satellite EO has led to a surge of applications and dependencies in Australia and globally.
- All of the satellite EO data utilised by Australia originates from foreign sources within all sectors - government, research, and commercial. Currently most of the key data sources - importantly, free and open sources - are without binding data supply agreements to support supply risk management and mitigation. This includes foundational data supply from the Landsat program (USA/USGS, NASA), the Copernicus program (European Commission), and from various foreign weather satellite operators.
- The foreign dependence and ownership of EO infrastructure presents significant risks for Australia at the time of this report. These risks warrant assessment and tracking to determine any changes in the associated risk levels into the future.
- This report identifies and analyses 39 such risks in terms of impacts to the Australian economy and international relations, in the categories of policy, market, programmatic, technical, and environmental.
- Of these 39 risks, six were rated as having a 'very high' risk impact based on their likelihood and consequence. In addition, 32 of the 39 have a likelihood rating between possible and almost certain.

We acknowledge that since the report was prepared, the Australian Government has announced the Landsat Next Partnership Program, including investment of $207.4m and ongoing funding, to secure Australia's role in the US Landsat program (Australia to join US satellite program in Landsat 2030 International Partnerships Initiative | Ministers for the Department of Industry, Science and Resources). As the program was announced on 22 March 2024, it is not possible to assess its impact on the risk assessment as the report was completed prior to this date. The next version of the Continuity of Earth Observation Data for Australia: Risks report will therefore assess the impact the program's investments have had on the risk profile based on program delivery at that point.

Table EB1: Distribution of risks across risk levels

	Consequence					
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe	Total
Almost certain	0	0	2	6	0	8
Likely	0	2	6	1	0	9
Possible	0	5	6	5	0	16
Unlikely	0	0	2	1	0	3
Rare	0	1	0	2	0	3
Total	0	8	16	15	0	39

Risk levels: Low, Minor, Medium, High, Very High

Executive Summary

Earth observations (EO) from space play an important role in supporting Australia's society and economy. They support the delivery of government services across almost all portfolios including weather forecasting, climate, agriculture, natural resources, infrastructure, environmental monitoring, mapping, and defence. Satellite EO also forms the evidence base for efficient and effective rules-based governance in many areas and underpins many commercial activities which profit from a secure, stable, and world class supply of EO satellite data. The satellites that provide this data can be considered as critical infrastructure.

This study identified 171 federal, state and territory government programs dependent on satellite EO data (see Appendix C). These programs are concerned with environmental issues, natural resource management, water, agriculture, meteorology, forestry, emergency management, tsunami and flood modelling, compliance, mapping and planning.

The study showed that of Australia's satellite EO dependent programs in government organisations, 135 (79%) are valued up to $10 million each and 160 (93%) have a medium to high dependency on EO data, demonstrating Australia's dependency on EO systems.

When data from the Landsat mission was made free and open in 2009, this signalled the effective start of an era of free and open land imaging satellite data. Previously data from this global coverage mission had been commercial, limiting supply and distribution. In the last 14 years, this change in access has significantly impacted the availability and use of satellite EO data globally, leading to a surge of applications and dependencies. However, there are few written assurances that 'free and open' will always be the case, and there is an overarching risk of complacency. Several of the risks identified in this report point to geopolitical, technological, and economic dynamics which have the potential to alter the free and open data landscape. A proactive approach is essential to ensure a resilient and sustainable supply of EO data to ensure the Australian ecosystem remains viable and vibrant.

According to a 2021 study by Deloitte, satellite EO directly contributed $283 million to the Australian economy in 2020, underpinning over $2.5 billion of economic activity annually (0.2% of Australian GDP). Yet almost all the governmental and commercial satellite EO data utilised by Australia originates from international sources.

Australia currently relies on foreign sources of satellite EO data. This dependence introduces vulnerabilities for a stable and secure economy, society, and environment with potential to impact government services, research initiatives and commercial ventures. To gain a comprehensive understanding of these vulnerabilities, this study has taken a methodical approach to identifying, analysing, and evaluating the risks associated with accessing satellite EO data. These risks have been grouped into five categories:

- **Policy:** Uncertainty and potential negative effects that arise from changes in foreign and domestic government policies, regulations, laws, or political decisions, or the consequences of geopolitical instability.
- **Market:** Potential disruptions or fluctuations in the availability or cost of a product due to changes in overall market conditions.

- **Programmatic:** Uncertainties and potential negative outcomes associated with the planning, execution, and management of a program or a set of related projects.
- **Environmental:** Potential disruptions or damages to satellites due to various space-related phenomena and conditions that could impact the ability to collect, transmit, and process EO data.
- **Technical:** Potential disruptions, inaccuracies, or failures in the collection, transmission, or processing of satellite EO data due to technological challenges or malfunctions.

This study has identified 39 potential risks to the supply of satellite EO data for Australia and has evaluated these risks against consequences pertaining to the **Australian economy** and **international relations**. Table EB1 shows the distribution of these risks across the different risk levels.

Six risks with a rating of 'very high' have been identified (Table ES1):

- Almost all of Australia's EO data supply is subject to decisions taken by foreign governments around open and free data supply, a policy of global acquisitions, and the global distribution of data. This is true for both public and commercial sources. *[Risks PO1, PO2, PO4]*
- The lack of binding supply arrangements with key providers creates an insecure situation where Australia is vulnerable to 'overnight' changes in foreign data policy. These changes can, and have, led to sudden and disorderly disruptions in key data supply chains with impacts on the delivery of Australian programs and businesses. Examples of such sudden changes include by Japan (where a change to the data policy for the Advanced Land Observing Satellite (ALOS) led to actual and abrupt supply loss), the United States of America (where the United States Geological Survey (USGS) Landsat program periodically reconsiders its free and open data policy, often based on political pressures from Congress, and; access to operational EO meteorological and other data streams from National Oceanic and Atmospheric Administration (NOAA) are lost during United States government shutdowns), and Europe (where the Copernicus data policy has been under past pressure from European industry). Increases in regional or geopolitical instability amplify these risks. *[Risks PO6, PO9]*
- The lack of government investment in domestic EO capability leads to increased exposure to supply chain disruption because international partners may limit supply due to lack of burden sharing, and because domestic industry hesitates to invest due to a lack of government investment surety (i.e. no anchor customer). *[Risk PR8]*

Table ES1: Six risks evaluated as 'very high'

Risk	Overall Rating
PO1: Foreign government open/free data or distribution policy change	**VERY HIGH**
PO2: Foreign government acquisition strategy change	**VERY HIGH**
PO4: Change in foreign partner government policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs	**VERY HIGH**
PO6: Lack of binding data supply agreements with key providers leads to sudden demise of supply	**VERY HIGH**
PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension	**VERY HIGH**
PR8: Inability or delayed ability to respond to future data supply risks	**VERY HIGH**

PO risks = Policy; PR risks = Programmatic

Based on the study, several conclusions can be drawn.

1. **Priority Risks:** The study categorises risks with a 'very high' likelihood of occurrence as 'almost certain.' These risks should be prioritised in mitigation strategies.
2. **Dependence on Foreign Data:** Australia's reliance on foreign data suppliers, without binding supply agreements, exposes the nation to the risk of sudden data supply disruptions. This is a particular concern for data from key missions like Landsat and the Copernicus Sentinel.
3. **Geopolitical Instability:** The changing geopolitical landscape increases uncertainty around data policy changes, emphasising the need for monitoring and flexible policy responses.
4. **Space Environmental Risks:** Potential 'black swan' events, such as orbital degradation from debris and natural disasters like solar flares, though not highly rated, require contingency planning due to their unprecedented nature and potentially devastating impact.
5. **Technical Risks:** Medium to high-rated technical risks, including data provenance, calibration, validation, and training data, are intensifying. The rapid evolution of technology, including the threat of cyberattacks and the challenge of discerning 'deep fakes', underscores the need for continuous vigilance and adaptive strategies.
6. **Risk of Complacency:** The current relative abundance of EO data supply poses a risk of complacency towards the dynamic geopolitical, technological, and economic factors that could alter the data access landscape.

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1. Introduction

1.1. Purpose and Scope

Earth observations (EO) from space can be considered as critical infrastructure to support Australian society and the economy. They support the delivery of government services across almost all portfolios including weather forecasting, climate, agriculture, infrastructure, resources, environmental monitoring, mapping, and defence.

In order to understand the use of EO in Australia, the Australian Government is seeking to understand different aspects of the continuity of EO data, covering the use of EO in government (civil), research and commercial applications and services.

The work addressed by this report involves the identification and analysis of the risk of EO supply to Australia using the methodology outlined in the International Standard on Risk Management (AS ISO 31000:2018 (ISO 31000), described in Section 2).

Understanding risks is essential, recognising that satellite EO is also a critical technology for the development of new and innovative research, and underpins many commercial activities. According to a study by Deloitte (2021), EO directly contributed $283 million to the Australian economy in 2020, underpinning over $2.5 billion of activity annually (0.2% of Australian Gross Domestic Product (GDP)).

The current study has identified more than 170 government programs dependent on EO data. These programs are concerned with environmental issues, natural resource management, water, agriculture, meteorology, forestry, emergency management, tsunami and flood modelling, compliance, mapping and planning. Around three quarters of these programs have a high dependency on EO data. EO dependency by program size is summarised in Figure 1.

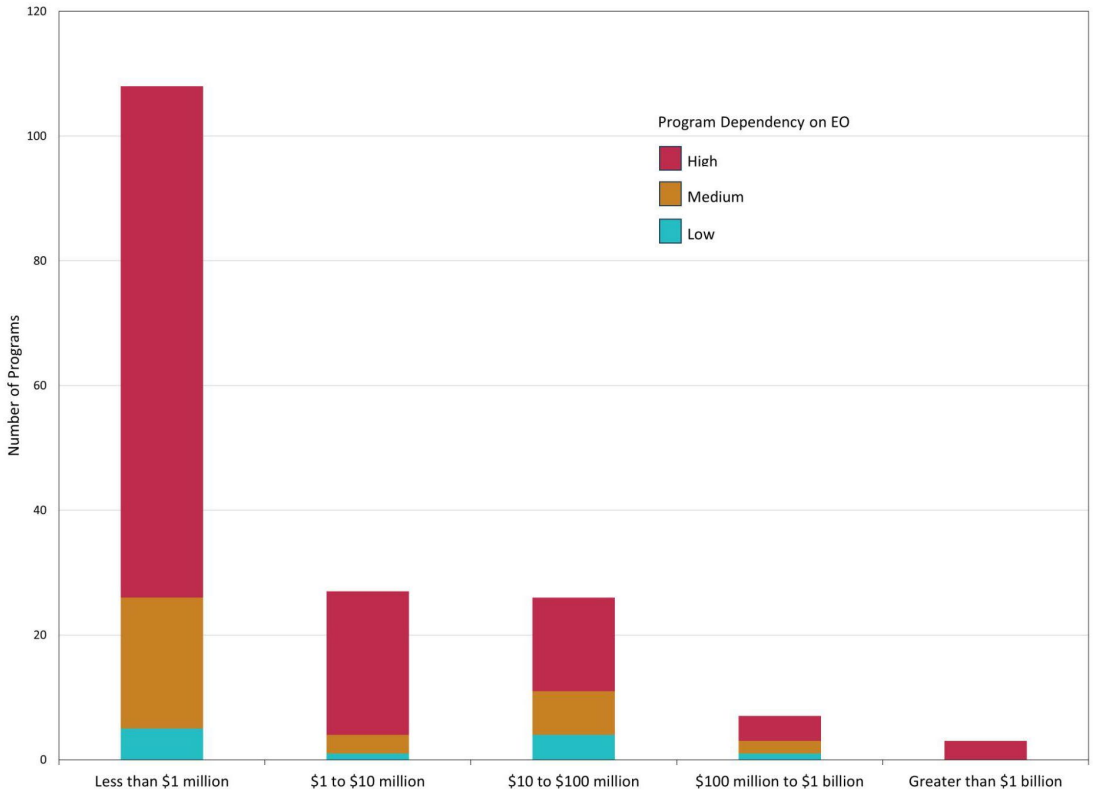


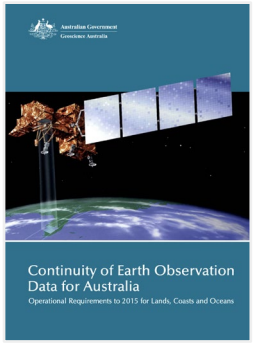
Figure 1: Summary of Australian Federal and State/Territory programs dependent on EO

Commercially, EO is used throughout the economy from small-medium enterprises (SMEs) to major insurers and multinational mining companies. Industry uses a variety of EO data types, including publicly produced and privately procured datasets.

1.2. Context

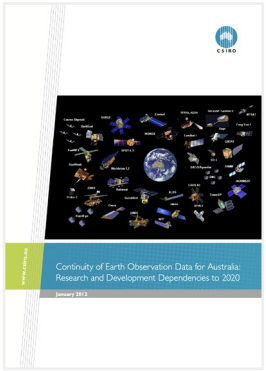
Australia relies on foreign sources for all satellite EO data supply, which introduces risks for critical government services, defence operations, commercial ventures, and research and education activities.

This latest report commissioned by the Australian Government builds on a series of previous studies going back more than 10 years, looking at Australia's Earth observation sector. These studies were collaborative efforts involving key agencies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Geoscience Australia, and the Bureau of Meteorology (BOM). They focused on outlining the risks, requirements, and impacts of EO data on the country. The table below summarises the previous studies, starting with the original three reports that serve as a foundational model for the current work.



2011 CEODA-Ops: Continuity of Earth Observation Data for Australia: Operational Requirements to 2015 for Lands, Coasts and Oceans (Geoscience Australia, 2011)

- Assessing requirements for satellite EO data in Australia.
- Accompanied by The Economic Value of Earth Observation from Space (ACIL Tasman, 2010), which established areas of impact for assessment.

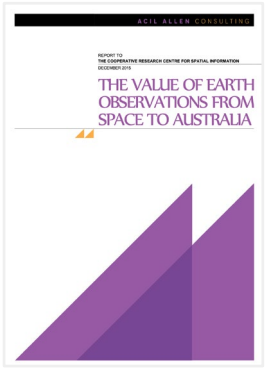


2012 CEODA-Research and Development: Continuity of Earth Observation Data for Australia: Research and Development Dependencies to 2020 (CSIRO, 2012)

- Published by CSIRO as a companion report to 2011 CEODA-Ops, covering requirements for research and development activities.
- Priority data types informed by The Economic Value of Earth Observation from Space (ACIL Tasman, 2010) based on impact.

2015: Risks of Data Supply of Earth Observations from Space for Australia (Symbios, 2015)

- Published as a follow-up to CEODA-Ops 2011, reflecting up to date information.



2015: The Value of Earth Observations from Space to Australia (CRCSI *et al.,* 2015)

- Addressed gaps in past economic assessments by examining in greater detail the current and potential economic benefits resulting from new and emerging EO applications.
- Estimated the likely socio-economic value of EO in 2025 for the Australian economy.

2016: Australian Government Earth Observation Data Requirements to 2025 (Australian Government, 2016)

- Examined current and projected requirements of Australian government programmes.
- Updated the 2011 Continuity of Earth Observation Data for Australia: Operational Requirements to 2015 for Lands, Coasts and Oceans.

2019: Current and Future Value of Earth and Marine Observing to the Asia-Pacific Region (Australian Government and APEC, 2019)

- Calculated the current economic value of Earth and marine observing to APEC economies, and estimated the potential value of Earth and marine observing by 2030, including from additional collaboration. The economic contribution was derived from its application to industry (for example to transport, utilities or agriculture), to disaster management, and to broader society.

2021: Economic Study into an Australian Continuous Launch Small Satellite Program for Earth Observation (Deloitte, 2021)

- A detailed economic study of Australia's EO sector.
- Estimated the economic contribution of the EO sector and its benefits to end users of EO data across the Australian economy.
- Estimated the impact of a denial of service event (DOS) to the EO sector and end users of EO data.
- Estimated the potential economic impact of a hypothetical EO satellite program.

Whilst useful in providing the foundation for further policies, strategies, and community plans, these studies have not been systematically undertaken or updated. Much has changed since the last risk analysis of 2015 and requirements analysis of 2016.

In addition to consideration of continuity risks, future work will ideally address other key aspects, relating to:

- **requirements of operational national programmes** for EO satellite data; documentation of current Australian EO data user requirements and dependencies based on community consultation.
- **the economic impact of EO** within Australia for key sectors of the economy including weather forecasting, climate, agriculture, infrastructure, environmental monitoring, mapping, finance, resources, and defence.

Ideally these three elements (risks, requirements, and economic impacts) would be kept current so that informed decisions and planning are possible at any time. Internationally, the gold standard for such an approach is adopted by the World Meteorological Organization (WMO) which has an ongoing Rolling Review of Requirements process covering needs, capabilities and outlook in order to ensure continuity of data critical to operational weather forecasting and other life-critical service needs.

1.3. Contents

This study has sought to provide an update on the risks to continuity of EO data supply for Australia and to establish an approach that might serve as the basis for a more systematic and regular update in future.

- **Section 2** provides an overview of the risk methodology, which follows standards set out in the International Standard on Risk Management — AS ISO 31000:2018 (ISO 31000).
- **Section 3** contains the risk identification and analysis, and links to the evidence compiled in Appendix B.
- **Section 4** contains a set of aggregate statistics of the risks analysed, as well as discussion and conclusions relating to the risks identified in the study.

2. Methodology: Understanding and Quantifying Supply Risk

2.1. Report Methodology

The methodology used in this report for risk assessment is a two-step process of risk identification, followed by risk analysis. It has been designed to meet the standards set out in the International Standard on Risk Management — AS ISO 31000:2018 (ISO 31000).

2.2. Risk Identification

Risk identification involves recognising and describing sources of risk and events that might cause consequences impacting an organisation's ability to function optimally or meet its goals:

- sources of risk - these can be internal or external to the organisation and might include financial uncertainty, legal liabilities, strategic management decisions, accidents, disaster response, or threats from competition;
- events (and their causes) - what specific occurrences (events) might happen that will originate from the sources of risk? What could cause these events?

The risks upon which this report focuses have potential consequences in two areas: the **Australian economy** and **Australian international relations**. While EO data supply interruptions have the potential to cause consequences and risks to other areas (i.e., national security, research, education, employment), they were not the primary focus of this report. Focusing on the Australian economy and Australian international relations provides a broad perspective on both domestic and external implications (and includes many of the other areas). For example, the Australian economy is intrinsically linked to EO data, influencing sectors from agriculture to transportation, and any disruption can have cascading effects on growth, innovation, and job security. On the other hand, Australian international relations provide insight into the geopolitical dynamics, dependencies, and collaborations that shape EO data access and sharing.

The following methods were used to compile a list of risks that are relevant to civil use of EO data across government, research, and commercial applications:

- **Literature review:** including academic and news publications, and credible online sources which can be referenced.
- **Survey:** Approximately 140 survey responses were received from an online survey sent out to recipients across government, research and industry and promoted through Geoscience Australia and Earth Observation Australia (see Appendix D for survey questions).
- **Interviews:** a total of 32 follow up interviews with a spread across government, research, and industry (10 government interviews, 7 research and education interviews, 15 industry interviews; full breakdown given in Appendix E).
- **List of EO-dependent programs in Commonwealth, and State and Territory Agencies:** a list of programs supporting critical civilian services within Australia has been compiled through the course of the survey and interview process, augmented by phone calls, emails, and program web pages (Appendix C). The table provides the context to analyse risk to the Australian economy and international partnerships.

Given the rapid pace at which the space and EO sectors are moving we anticipate the information and findings may date over the period of a few years and will need to be refreshed.

2.3. Risk Analysis

Risk analysis is the process of understanding the nature, sources, and causes of the risks that have been identified. In this stage, the potential consequences and their likelihood were assessed, and the level of risk was estimated.

The risk analysis adopts a widely recognised framework for measuring likelihood (Table 1) and consequence (Table 2) based on the Protective Security Policy Framework (PSPF), a tool designed to assist Australian Government entities in safeguarding their personnel, information, and assets both domestically and internationally (Australian Government Department of Home Affairs, 2021). The risk analysis uses the Business Impact Levels tool from the PSPFs (Table 2), to assess potential damage to national interests, governmental institutions, organisations, or individuals (Australian Government Department of Home Affairs, 2018). The 'Business Impact Rating' is equivalent to the 'Consequence Rating,' with the nomenclature outlined in Table 2 below. For the purposes of our risk analysis, we focus specifically on the sub-impact categories pertaining to the Australian economy and international relations, as they are the most pertinent to the topic area risk management for satellite EO data supply.

2.4. Risk Trend Assessment

An assessment of the risk trend as either decreasing, neutral (no change) or increasing was completed for each individual risk. The trend is the projected trajectory of the risk from the current time into the future. For a risk that has an increasing trend, it would be expected that the overall risk level would be higher at the next cycle of assessment. The trend trajectory was estimated by the study team based on the comprehensive review of evidence for EO supply risk undertaken in this report, and assessment of the likely ramifications for future risk level based on the current economic and geopolitical outlook.

2.5. Risk Assessment Steps

The first step was to assign each of the identified risks a 'Likelihood Rating', as shown in Table 1.

Table 1: Risk Likelihood Ratings

Likelihood ratings				
Rare Less than 10% May occur only in exceptional circumstances	**Unlikely** From 10% to < 35% Should not occur in most circumstances	**Possible** From 35% to < 65% Could occur at some time	**Likely** From 65% to < 90% Should occur in many circumstances	**Almost certain** ≥ 90% to <100% Expected to occur in most circumstances

The next step was then to assign each of the identified risks a 'Consequence Rating' for each of the two 'impact categories' (Australian economy and international relations). The final 'Consequence Rating' is defined to be the higher rating from each of the (two) impact categories used in the analysis i.e., if the *Australian economy consequence rating* is higher than the *international relations consequence rating*, then the final consequence rating will be reported as that of the *Australian economy* level.

Table 2: Risk Consequence Ratings

Consequence ratings					
Impact category	**Insignificant**	**Minimal**	**Moderate**	**Substantial**	**Severe**
Australian economy	Information from routine business operations and services.	Limited damage to government is: a. undermining the financial viability of one or more individuals, minor Australian-based or owned organisations or companies b. disadvantaging a major Australian organisation or company.	Damage to the national interest is: a. undermining the financial viability of a major Australian-based or owned organisation or company b. disadvantaging a number of major Australian organisations or companies c. short-term material impact on national finances or economy.	Serious damage to the national interest is: a. undermining the financial viability of an Australian industry sector (multiple major organisations in the same sector) b. long-term damage to the Australian economy to an estimated total in excess of $20 billion.	Exceptionally grave damage to the national interest is the collapse of the Australian economy.
International relations	Information from routine business operations and diplomatic activities.	Limited damage to government is minor and incidental damage or disruption to diplomatic relations.	Damage to the national interest is: a. short-term damage or disruption to diplomatic relations b. disadvantaging Australia in international negotiations or strategy.	Serious damage to the national interest is: a. severely disadvantaging Australia in major international negotiations or strategy b. directly threatening internal stability of friendly countries, leading to widespread instability c. raising international tension or severely disrupting diplomatic	Exceptionally grave damage to the national interest is directly provoking international conflict or causing exceptionally grave damage to relations with friendly countries.

			relations resulting in formal protest or sanction.	

The 'risk level' from minor to very high (likelihood × consequence rating) was calculated using the function shown in Table 3.

Table 3: Risk Level Function

	Consequence				
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe
Almost certain	Minor	Medium	High	Very High	Very High
Likely	Minor	Medium	Medium	High	Very High
Possible	Low	Minor	Medium	High	Very High
Unlikely	Low	Minor	Minor	Medium	High
Rare	Low	Low	Minor	Medium	High

3. Identification and Analysis of Satellite Earth Observation Supply Risks to Australia

Australia's inability to access essential satellite EO data for governmental and civilian purposes could result in significant loss of life, property damage, and economic downturns in sectors dependent on such data. In this section, the risks to supply of EO data for Australia are identified and analysed. The risks have been categorised into: policy, market, programmatic, environmental and technical risk types. For each risk identified, there is an assessment of both likelihood and consequence with an analysis assigning an overall risk rating according to the process outlined in Section 2.

Evidence gathered to support these risks is documented in Appendix B of this report and referenced throughout this section under the individual risk analysis.

3.1 Policy Risks

Policy risks encompass the uncertainties and potential adverse effects stemming from shifts in foreign and domestic government policies, legal frameworks, and regulatory landscapes. They also consider the repercussions of political decisions and the broader implications of geopolitical instability. These risks highlight the vulnerability of EO data supply to shifting political tides and the importance of navigating the policy environment with foresight and agility.

The policy risks considered in this section are summarised in Table 4.

Table 4: Policy Risks and Overall Ratings

Risk	Overall Rating
PO1: Foreign government open/free data or distribution policy change	VERY HIGH
PO2: Foreign government acquisition strategy change	VERY HIGH
PO3: Foreign government exercises shutter or export controls for strategic or tactical reasons	HIGH
PO4: Change in foreign partner government policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs	VERY HIGH
PO5: Poor Australian burden-sharing leads to data providers not willing to provide free data to Australia	HIGH
PO6: Lack of binding data supply agreements with key providers leads to sudden demise of supply	VERY HIGH
PO7: Change to WMO data policy or country participation	HIGH
PO8: Australia or strategic partners' access to satellite launchers is restricted for strategic, geopolitical, or tactical reasons	MEDIUM
PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension	VERY HIGH
PO10: Australian Government policy restricts use of EO data sources from foreign governments and companies	MEDIUM

Risk	Overall Rating
PO11: Australia prioritises foreign partnerships in EO based on national security or defence needs, instead of civilian needs	**MEDIUM**

3.1.1 PO1: Foreign government open/free data or distribution policy change

Risk	Key international providers of EO data to Australia include entities like the European Space Agency (ESA), European Commission (EC), National Oceanic and Atmospheric Administration (NOAA), United States Geological Survey (USGS), Japan Meteorological Agency (JMA) and Japan Aerospace Exploration Agency (JAXA). There are no definitive bilateral service level agreements, or treaties between governments guaranteeing the ongoing supply of this data to Australia. Any changes in foreign governments' policies, be they political, financial, or trade-related, could limit or entirely halt EO data supply to Australia. Past examples include the ALOS (Japan) and Landsat (US) missions. During the Landsat commercial phase in 2001 users paid around $1,100 per Landsat scene.
Assessment	Changes in foreign government policies could limit Australia's access to certain EO data streams, potentially shifting from free to paid access. This could result in program budgets no longer being sufficient to purchase the required data and unviable business models for commercial services.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Almost Certain	Previous changes have occurred in foreign governments' open or free data policy, and it is almost certain that there will be a change in both the short-term (2-5 years) and longer term (>5 years). Some changes could potentially be positive in impact. Distribution strategy change that disadvantages Australia has occurred in the past and is almost certain to occur in the future.	Australian Economy: **Substantial**	Alterations to foreign government EO data policies and distribution strategies have the potential to disrupt multiple sectors in Australia (multiple major organisations in the same sector).
		International Relations: **Substantial**	Alterations to foreign government EO data policies and distribution strategies could severely disadvantage Australia in major international negotiations or strategy including reporting commitments for major conventions.

Overall: **VERY HIGH**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.2, B.3, B.5, B.6, B.8, B.15, B.23, B.27

3.1.2 PO2: Foreign government acquisition strategy change

Risk	Image acquisition over Australia is not typically prioritised by foreign satellite operators. For example, in the Sentinel-1 establishment phase of ESA, most of Australia was excluded; recent adjustments to the Sentinel-1 coverage in response to the Sentinel-1B failure have reduced coverage for large parts of Australia, in part in deference to European priorities. Other countries including Argentina, Canada, China, and many others prioritise the capture of data over their sovereign territory or strategic areas of interest. The joint NASA and Indian Space Research Organisation (ISRO) mission NASA-ISRO Synthetic Aperture Radar (NISAR), will only capture S-Band SAR imagery over areas of Indian interest. Australia's reliance on foreign space programs for satellite imagery acquisition limits our access and prioritisation in obtaining crucial data.
Assessment	Australia's dependence on EO data acquisition strategies set by foreign governments, which might not resonate with its own priorities, risks undermining vital services in multiple areas. This reliance can result in data collection that does not align with Australia's needs, diminished data quality, and challenges in swiftly responding to emergencies. As foreign governments adjust their acquisition strategies or as the focus shifts to global commercial services not designed for Australia's requirements, the challenges intensify. Internationally, restricted data access may weaken Australia's standing in global discussions. Such dynamics could push Australia to rely more on a limited number of partners, affecting its strategic independence and global image.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	Acquisition strategy change that disadvantages Australia has occurred in the past and is almost certain to occur in the future.	Australian Economy: **Substantial**	A change in foreign government EO acquisition strategy could undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector).
		International Relations: **Substantial**	A change in foreign government EO acquisition strategy could severely disadvantage Australia in major international negotiations or strategy.

Overall: **VERY HIGH**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.1, B.2, B.3, B.5, B.8, B.23

3.1.3 PO3: Foreign government exercises shutter or export controls for strategic or tactical reasons

Risk

Shutter control is the generic name given to regulatory measures that allow governments to limit or restrict commercial satellite operators from collecting or distributing satellite imagery for reasons such as national security, foreign policy, or other sensitivities. Typically implemented through licensing agreements which prohibit the acquisition and sale of imagery over particular locations, shutter control can be invoked during scenarios like military operations, diplomatic events, or around sensitive facilities. While it serves to protect national interests, the practice can also restrict sales potential for commercial satellite companies including around periods of significant commercial potential as highlighted by the Russia-Ukraine conflict. The same licensing dictates the resolution of imagery that a commercial operator can sell, with restrictions placed on high resolution images above certain thresholds.

Foreign regulations prohibiting the export of key commercial data supply to Australia would impact multiple sectors - leading to inefficiencies and potential economic losses. The sudden data void could hinder research, development, and decision-making processes that are contingent on timely and accurate data. Strategically, such prohibitions could strain diplomatic relations between Australia and the data-exporting nations, necessitating renegotiations or even leading to broader trade disputes. Australia might be compelled to seek alternative data sources, which could become costlier or less reliable. Over time, this reliance on foreign data and the vulnerability to external regulatory changes could erode Australia's competitive edge in the global market, potentially impacting its economic growth and international standing.

Assessment

Shutter control and export regulations can curtail Australia's ability to access prompt, high-resolution satellite images, which may impede crucial decisions in areas like defence and disaster management. Such restrictions can also expose national security gaps due to the inaccessibility of vital data. Given that shutter control specifically targets the resolution of images, sectors like agriculture, mining, and urban planning, which particularly benefit from ultra-high-resolution imagery, find themselves at a disadvantage. As a result, these industries often resort to aerial or drone imagery for high precision, without the timeliness and repeatability advantages that satellite imagery offers.

Likelihood	Analysis	Consequence	Analysis
Possible	While shutter and export controls on key data including commercial data already exist, it is possible that the level of restriction could change based on strategic or tactical reasons.	Australian Economy: **Substantial**	Foreign government shutter control policies or regulations restricting key commercial data exports could substantially undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector) who rely on high resolution EO imagery. Impacts could hinder research and decision-making, and force Australia to seek alternative, potentially less reliable data sources, thereby impacting its global competitiveness and economic standing.

3.1.3 PO3: Foreign government exercises shutter or export controls for strategic or tactical reasons

	International Relations: **Substantial** 	A change in foreign government shutter control policy could substantially disadvantage Australia in major international negotiations or strategy. Limiting EO data access to Australia could weaken its position in international talks and strain its diplomatic ties with the restricting country.
Overall:		
Risk Trend: Decreasing		
Evidence: See Appendix B Sections B.1, B.2, B.3, B.4, B.5, B.6, B.7, B.8, B.11, B.12, B.13, B.15, B.18, B.23		

3.1.4 PO4: Change in foreign partner government policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs

Risk	Instead of continuing to prioritise and invest in innovative EO systems for operational or scientific purposes that serve international needs, foreign partner governments might redirect their focus towards more immediate domestic concerns. Such a shift could arise from various reasons, including economic challenges, political changes, or evolving national security needs. Western nations are facing heightened competition from countries advancing their EO capabilities and policies (Satellite Industry Association, 2022). This growing rivalry challenges the West's leadership and influence in the EO domain. Australia, heavily reliant on EO data from the US, Europe, and Japan, risks lagging behind countries like China in relation to its use of EO. In some circles, Australia is already seen as lagging in this area, as China has strong investment policies for increasing EO data use and domestic space capabilities (Beames, 2023). If Australia cannot rely on its global partners to provide EO data to meet its requirements or that data is no longer at the forefront of global technological advancement, this could lead to Australia needing to procure satellite imagery from less trusted countries – with associated data safety and cybersecurity risks.
Assessment	International partners or beneficiaries of the previous policy could experience reduced access to advanced satellite EO data, potential delays in collaborative projects, and a need to reconsider their own satellite strategies or seek alternative partners. Changes may mean that foreign countries' space programs no longer meet the needs of Australia. As Australia is heavily reliant on EO data (imagery, radar, sounders) from foreign partners, should one of the major partners such as the US or Europe fall behind in their ambition or reprioritise national resources away from EO programs, Australia would be substantially disadvantaged. Australia's significant dependence on foreign partners for many types of EO data presents multifaceted risks. A decline in partner leadership in the EO domain could reduce Australian capabilities relative to other nations. This could potentially diminish Australia's competitive edge in sectors reliant on advanced EO capabilities, and potentially undermine the confidence and trust in the services delivered for Australians. New EO data providers, especially from nations with existing geopolitical tensions, could introduce security vulnerabilities and data privacy concerns. Economic setbacks might arise if there is a delay or lack of access to crucial EO data. Changes in global EO dynamics might also hinder Australia's disaster response efficiency, necessitate a re-evaluation of strategic partnerships, and lead to increased costs as Australia seeks to bolster its domestic EO capabilities.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Almost Certain	Foreign partner policy has currently fallen behind that of other nations and is almost certain to occur in the future.	Australian Economy: **Substantial**	Due to Australia's almost complete reliance on foreign partners for EO this could mean Australian entities cannot access commercial data to meet their ongoing needs. It could undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector).

3.1.4 PO4: Change in foreign partner government policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs

	International Relations: **Substantial**	The lack of cutting-edge technology investment in EO by foreign partners could result in other countries coming to the forefront. Where there are existing tensions with these countries, Australia may find diplomatic tensions are substantially impacted. This could be particularly true if the EO data is only supplied for some sort of alliance in return, and if Australia's current regional allies were to shift alliances based on benefits associated with receiving information from more advanced technology.

Overall: **VERY HIGH**

Risk Trend: Neutral 

Evidence: See Appendix B Sections B.1, B.2, B.3, B.4, B.5, B.6, B.7, B.8, B.11, B.12, B.13, B.18, B.23, B.24, B.25, B.33

3.1.5 PO5: Poor Australian burden-sharing leads to data providers not willing to provide free data to Australia

Risk	While Australia relies heavily on foreign EO data for crucial applications, its limited contribution and investment in satellite missions leaves open the possibility for concerns about inadequate burden sharing with key data supply partners and the global EO community broadly. This perceived imbalance could potentially erode goodwill from international partners and result in data donor fatigue with Australia. Failing to respond to this at a global level, including with US, European and Asian countries, could weaken Australia's standing in global forums, influencing its broader diplomatic and trade relations.
Assessment	Australia's notable reliance on foreign EO data supply, coupled with its limited contributions to the deployment of satellite missions, may contribute to a perception that it is a less active participant in the global EO community. Australia does make investments which are key for international partner engagement (e.g., calibration/validation (cal/val) services, Open Data Cube development), but should these investments decrease or be considered insufficient by our key data donors, this could jeopardise the goodwill and collaborative spirit of international partners.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Possible	It is possible that Australia's international reputation will be degraded, due to its almost complete reliance on foreign partners to supply EO data, without providing any in return from Australia.	Australian Economy: **Substantial**	The loss of supply due to Australia's international reputation being degraded, could substantially undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector) who rely on EO imagery.
		International Relations: **Substantial**	The damage to Australia's international reputation due to poor Australian burden sharing with provision of EO data and satellite infrastructure could substantially disadvantage Australia in major international negotiations or strategy.

Overall: **HIGH**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.1, B.3, B.5, B.8, B.23, B.27

3.1.6 PO6: Lack of binding data supply agreements with key providers leads to sudden demise of supply

Risk	International partnerships play a pivotal role in ensuring Australia's access to EO data. However, in the absence of formalised and binding agreements with primary EO data providers, Australia stands vulnerable to unforeseen disruptions, data gaps, or even unilateral restrictions in data supply. A more resilient and sustainable EO data ecosystem for the nation's future needs would require greater certainty from international data supply agreements. No such binding treaties exist in the Australian context to secure the supply of satellite EO data. Such a treaty with the US for example might insulate Australia from changes to the Landsat data policy.
Assessment	The absence of binding data supply agreements with principal providers could have significant repercussions for Australia. A sudden or disorderly cessation of supply could disrupt essential services, from meteorology to national security, hindering timely decision-making and response mechanisms. Such unpredictability in data access might also strain Australia's economic sectors that heavily rely on this data, potentially causing financial setbacks. Furthermore, the need to hastily secure alternative data sources could compromise quality and increase costs. This instability could also erode trust in international partnerships and necessitate urgent diplomatic and strategic realignments to safeguard Australia's interests.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	Sudden changes in data agreements have previously occurred. Without these agreements being binding, changes are almost certain to occur in the future.	Australian Economy: **Substantial**	A change in data agreements could substantially undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector) who rely on EO imagery.
		International Relations: **Substantial**	A change in data agreements could substantially disadvantage Australia in major international negotiations or strategy.

Overall: **VERY HIGH**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.3, B.5, B.8, B.11, B.12, B.13

3.1.7 PO7: Change to WMO data policy or country participation

Risk

The current framework established by the WMO Unified Data Policy (UDP Res.1) governs the international dissemination and exchange of meteorological and related data. This resolution segments data and products into:

- Essential Data: Crucial data and products for safeguarding lives, properties, and the overall well-being of nations, which are mandatorily shared freely and without any limitations.
- Additional Data and Products: These are disseminated based on specific bilateral or multilateral agreements between member nations. There may also be costs involved depending on the satellite operator's data policy.
- Commercial Data and Products: Data exchanged following agreements established between data providers and their users.

Additionally, the WMO operates the WMO Information System (WIS), a comprehensive system promoting all WMO endeavours by enabling routine data collection, automated distribution, data discovery, retrieval, and publication. Any alterations or deviations from this established framework could lead to uncertainties and disruptions in the current modes of data access, sharing, and commercial exchanges, which might impact a range of stakeholders.

Countries may at their own discretion, change their data policy within the WMO Resolution 1, or they could stop or adjust their adherence to WMO guidelines, effectively signalling their withdrawal from data supply agreements.

Australia benefits from this free and open exchange of satellite data under the WMO UDP, however the risk here is that the data policy could change including due to commercial pressures in other countries, and the data is either no longer supplied, or no longer free and open under a policy change. There is increasing use of commercial data by operational weather agencies in the US and Europe, and it remains to be seen where this trend will lead. Australia would be unable to domestically source the capability to develop its own satellites to replace any such disruptions in supply.

Assessment

While the World Meteorological Organization (WMO) tends to evolve its policies incrementally based on clear needs, any significant change to its data-sharing policy, particularly one restricting data access or use, would have widespread consequences. Such alterations could impact various sectors, from jeopardising public safety due to restricted meteorological data access, to causing economic repercussions for industries reliant on this data, like agriculture and aviation. Diplomatic relations might be strained if data-sharing agreements are modified, and scientific research in climate and atmospheric sciences could face setbacks. Operational challenges could arise for meteorological services, and the commercial sector might experience disruptions, potentially deterring innovation, and investments in meteorological technologies. Furthermore, a perceived profit-driven policy shift might diminish trust in the WMO as a global entity serving the public interest.

If individual countries were to effectively withdraw from the WMO data sharing framework (withdraw their support and contribution by reducing their adherence to relevant WMO guidelines), it might introduce uncertainties and interruptions in the existing methods of data acquisition, dissemination, and business exchanges, potentially affecting numerous stakeholders. The consequences of countries withdrawing would depend on which countries were involved, and their respective contribution and reliance of the WMO on data from these countries. Past examples have happened but generally not reached the level of service disruption for Australia. While unlikely, it is possible that this could reach a point where it could disrupt the consistent flow of essential meteorological data to Australia. This would be particularly acute if it were countries that Australia relies on for meteorological data such as Japan or China. The significant changes in the sector and its use of commercially-purchased data have yet to be properly tested in the WMO data sharing context.

3.1.7 PO7: Change to WMO data policy or country participation

Likelihood	Analysis	Consequence	Analysis
Possible	A significant change restricting data access or use, to the WMO data sharing policy would need to be approved by all member parties. Given the widespread consequences for all, it is assessed as unlikely to occur. Individual countries might feasibly withdraw full or partial support from data sharing, including for new commercial data sources.	Australian Economy: **Substantial**	Loss of supply due to changes restricting WMO data sharing would cause exceptionally grave damage to the national interest.
		International Relations: **Substantial**	Loss of supply due to changes restricting WMO data sharing would cause exceptionally grave damage to the national interest.

Overall: HIGH

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.3, B.5, B.8, B.19, B.23, B.30

3.1.8 PO8: Australia or strategic partners' access to satellite launchers is restricted for strategic, geopolitical, or tactical reasons

Risk	Policy decisions to restrict launch access could be taken for a variety of reasons including strategic (to preserve a market); geopolitical (due to tensions between countries); or, tactical (related to military or other civilian needs). In a more conflicted world, the ability of Australia and its strategic partners to access launch services may be subject to trade restrictions, regulation, or other sanctions, either directly placed by Australia or its allies. For example, many countries are no longer using the Russian Soyuz rocket to launch satellites due to trade sanctions (Jones, 2023). Globally this restricts launch supply for Australia's strategic partners, and has the potential to cause a backlog and delays to planned launches, due to lack of launch slot availability. The narrowing of launcher options also heightens the potential impact of technical failures.
Assessment	If Australia or its strategic partners were denied access to satellite launchers, such restrictions would impede Australia's ability to deploy satellites, potentially hampering advancements in sectors reliant on satellite data. Beyond the immediate operational setbacks, geopolitical restrictions on satellite launch access can strain diplomatic relations, highlighting the vulnerabilities in Australia's space infrastructure dependencies. Such a scenario underscores the importance of diversifying satellite launch capabilities and partnerships, ensuring resilience.

Likelihood	Analysis	Consequence	Analysis
Possible	It is possible that Australia's or its strategic partners could be restricted access to international satellite launch facilities.	Australian Economy: **Moderate**	Restriction of access to international launch facilities, given Australia currently does not have these facilities, would disadvantage several major Australian organisations or companies that are planning to or have already launched satellites.
		International Relations: **Moderate**	Restriction of access to international launch facilities could be because of existing strained diplomatic relationships between Australia and the country for which the restrictions are in place.

Overall: **MEDIUM**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.2, B.3, B.5, B.6, B.20, B.23

3.1.9 PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension

Risk

Changes to foreign data provider policy could be caused by increases in geopolitical conflict or tension. This is likely to be reflected in restrictions in use of satellite data within Australia (particularly with regards to government data buys) from nations where there are tensions with Australia. It may also be reflected as an increase in Australian support to foreign governments to purchase or use EO data where Australia wishes to use soft power to create or maintain diplomatic, trade and foreign policy ties. An example could be where Australia assists a country to maintain and build EO access and capabilities for maritime domain awareness, particularly where another nation has or is likely to infringe sovereign maritime boundaries through activities such as fishing, military exercises, immigration through unapproved channels, maritime constructions, or any other activities.

In the event of significant foreign conflict, there is also a risk that pivotal data-supplying countries or companies might divert their attention and acquisition capacity, hindering supply to Australia. Many commercial satellites have data tasking arrangements for national security or defence needs. Due to this they will typically prioritise all national security and defence interests before civilian requirements, where they do not have collection capacity for both civilian and defence. This can impact civilian needs for EO data, rendering these EO sources either unavailable or delivered in an untimely manner.

Assessment

Policy changes, driven by geopolitical dynamics, might result in restrictions on the utilisation of satellite data within Australia, especially concerning government data acquisitions from nations with which Australia has delicate or nuanced relations. Other nations may also restrict Australia's access to data acquired by their sovereign satellites. Where the nation has significant capabilities in EO, this could mean that Australia does not have access to state-of-the-art technology and derived information. In this situation it could cause disadvantage, both for civilian decisions and national security.

If significant foreign conflicts divert the focus of key data provider countries away from supporting Australia, the consequences could be substantial. In conflict scenarios, commercial satellites are typically redirected to prioritise defence related areas of interest, leaving civilian needs largely unattended. For Australia, this could mean a severe disruption in the steady flow of essential satellite data. Additionally, the unpredictability of data supply during such times could strain Australia's emergency response capabilities, especially in situations requiring real-time satellite data.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	Changes in foreign policy have already occurred that restrict Australian access to EO data. It is also possible that foreign conflict causes international suppliers to reduce EO data supply to Australia, due to the demand for use of satellite resources to acquire EO images over conflict areas.	Australian Economy: **Substantial**	Where the restriction of supply of EO data due to changes in foreign policy because of increased geopolitical tension occurs, this could mean Australian entities cannot access commercial data to meet their ongoing needs. It could undermine the financial viability of an Australian industry sector (multiple major organisations in the same sector). Limited supply due to demand in conflict zones would have a similar impact.

3.1.9 PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension

	International Relations: **Substantial**	Where the restriction of supply of EO data due to changes in foreign policy because of increased geopolitical tension occurs, it could directly threaten internal stability of friendly countries, leading to widespread instability, particularly in situations where that data is used for natural disaster prediction and response, or agricultural production and management was lost. It may also substantially damage Australia's diplomatic relations where tensions exist between Australia and the other countries affected.
Overall:	**VERY HIGH**	
Risk Trend: Increasing		
Evidence: See Appendix B Sections B.1, B.3, B.5, B.6, B.7, B.8, B.11, B.15, B.22, B.23, B.27		

3.1.10 PO10: Australian Government policy restricts use of EO data sources from foreign governments and companies

Risk	If a foreign government's policies or actions were no longer aligned to those of Australia, the Australian Government could impose restrictions (e.g. trade) on the EO data sourced from that government. These policy changes could be general in nature and/or specifically with respect to the EO data collected and distributed.
Assessment	Changes in Commonwealth government policies that restrict access to existing or future data sources would reduce the available and accessible EO data pool, impacting existing or future programs and projects dependent on the now restricted datasets.

Likelihood	Analysis	Consequence	Analysis
Possible	It is possible that government policy restricts the use of EO data from foreign governments or companies.	Australian Economy: **Moderate**	By restricting the available EO data this could disadvantage a number of major Australian organisations or companies.
		International Relations: **Moderate**	Restricting the access to EO data for Australia, by excluding certain countries, could result in short-term damage or disruption to diplomatic relations (with those countries).

Overall: **MEDIUM**

Risk Trend: Increasing 

Evidence: See Appendix B Sections B.2, B.3, B.5, B.6, B.8, B.23

3.1.11 PO11: Australia prioritises foreign partnerships in EO based on national security or defence needs, instead of civilian needs

Risk	Australia focuses its foreign EO partnerships based on national security or defence needs, and aligns its domestic civilian EO programs similarly. This does or may limit the pool of countries with which it can collaborate with. Such a stance may potentially jeopardise Australia's standing as a trusted global partner and its commitment to global EO capability development.
Assessment	Prioritising foreign EO partnerships based on defence over civilian needs limits potential long-term collaborations and misses the expertise of nations with advanced EO programs.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Likely	It is likely that the prioritisation of foreign EO partnerships based on defence over civilian needs will continue to occur and impact Australia's collaborations.	Australian Economy: **Moderate**	By prioritising defence and national security needs, this could disadvantage a number of major Australian organisations or companies. These needs are unlikely to also meet the civilian EO data needs for services such as natural disaster response, environmental monitoring and other applications.
		International Relations: **Moderate**	A stronger defence posture for Australia in relation to prioritisation of EO data supply, could cause short-term damage or disruption to diplomatic relations, and disadvantage Australia in international negotiations and strategy. It may cause some countries to view Australia in a more threatening light, as well as reduce the humanitarian response and use of EO data that Australia provides to other countries.

Overall: **MEDIUM**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.1, B.3, B.4, B.5, B.6, B.8, B.22, B.23, B.25

3.2. Market Risks

Market risks refer to the potential disturbances or variations in the availability or cost of EO data products. These can emerge from changes in market dynamics, including supply dependencies, price volatility, regulatory shifts, and macroeconomic fluctuations. This section assesses how these factors could pose significant challenges to the steady and cost-effective supply of EO data to Australia.

The market risks considered in this section are summarised in Table 5.

Table 5: Market Risks and Overall Ratings

Risk	Overall Rating
M1: Potential disruptions or fluctuations in the availability or cost of a product due to changes in overall market conditions or market failures	**MEDIUM**
M2: Commercial market demand for on demand acquisition services saturates capacity	**MEDIUM**
M3: Changes to international free and open data policy reduce or impede commercial viability of EO products and services	**MEDIUM**
M4: Significant downturn in the Australian economy means foreign commercial data becomes too expensive for users	**MEDIUM**
M5: Globalisation means domestic Australian EO data service providers become too expensive	**HIGH**
M6: Obsolete or discontinued software and/or platforms	**MEDIUM**

3.1.2 M1: Potential disruptions or fluctuations in the availability or cost of a product due to changes in overall market conditions or market failures

Risk

Data supply is reliant on products and services furnished by the market, with key examples including data suppliers, tool providers, and infrastructure and cloud computing providers. Given the rapidly changing and relatively unregulated nature of these markets, there is strong potential for volatility, and significant market consolidation, possibly leading to market failure or 'winner take all' outcomes. Provision of data supply from governmental sources is generally more stable, and less at the mercy of commercial interests and forces. Some of the outcomes which could have a negative impact on data supply include:

- Consolidation in the data provider market which leads to monopolistic or oligopolistic market failure could reduce competition, reduce diversity of supply, decrease product differentiation, drive up prices sharply, or lead to supply situations with a limited number of suppliers who are less responsive;
- Disadvantageous market efficiencies created by price policies implemented by data providers. Commercial vendors already impose region-specific purchase limitations and apply differential pricing structures, and such region-based pricing strategies could mean higher costs or restricted access relative to users from other regions to develop services based on satellite EO; and,
- Modern EO data supply chains are increasingly dependent on commercial cloud computing infrastructure. Consolidation in the commercial cloud infrastructure space which leads to monopolistic or oligopolistic market failure could drive up prices sharply, and reduce options for product or service delivery.

In addition to placing supply at risk, and raising its cost, concentrated control of the marketplace could introduce high barriers to market entry for newcomers, in particular small-medium enterprises which are key to building Australia's national capacity.

Assessment

The marketplace is dynamic, ever changing, and difficult to control even with specific commercial arrangements in place. As such, fluctuations in the marketplace are very likely to take place. However, in terms of the consequence to Australian EO data supply, while the impacts may be high for some individual actors, these impacts would not be expected to significantly compromise economic viability or government reputation.

Likelihood	Analysis	Consequence	Analysis
Likely	The nature of the marketplace means that the supply of products and services will fluctuate with demand. Given the dynamic nature of the EO sector over the past 10-15 years, significant changes in the supply of products should be expected. Note that change could be both positive and negative in terms of	Australian Economy: **Moderate**	Fluctuations in the marketplace will not generally undermine the financial viability of individuals, minor Australian-based or owned organisations or companies. However, a monopolistic market failure in data supply or cloud computing infrastructure could result in economic strain, increased costs for consumers, business challenges, and deterred foreign investment. This could potentially disadvantage a number of major Australian organisations or companies.

3.1.2 M1: Potential disruptions or fluctuations in the availability or cost of a product due to changes in overall market conditions or market failures

capability.	International Relations: **Minimal**		Damage to the government due to fluctuations in the marketplace are likely to be minor with incidental damage or disruption to diplomatic relations.

Overall:	**MEDIUM**
Risk Trend: Neutral	
Evidence: See Appendix B Sections B.2, B.3, B.6, B.8, B.11, B.13, B.14, B.15, B.19, B.20, B.22, B.23	

3.2.2 M2: Commercial market demand for on-demand acquisition services saturates capacity

Risk	Demand exceeding supply may result in conflicts or unavailability of tasking for satellite acquisition. This issue can arise when one entity gains exclusive acquisition rights. For example, if an entity were to obtain exclusive access to high-resolution optical data over an area, it would effectively have caused an outcome similar to a shutter control policy (PO3). Similarly, heightened demand for areas north of Australia has inhibited satellite data acquisition over the Australian mainland. Conflicting requests (i.e., timing) for satellite image acquisition over the Australian mainland could also inhibit some stakeholders acquiring data (where the areas of interest differ). This demand saturation can create significant data access challenges.
Assessment	If the commercial market demand for on-demand acquisition services reaches saturation, the immediate consequence would be a potential delay or inability to access timely and specific satellite data, which could hinder various sectors. Such saturation could also drive up the costs of these services. Additionally, an overwhelmed system might compromise the quality and reliability of data. This scenario could also deter potential investors or businesses from entering the Australian market, fearing inadequate data availability.

Likelihood	Analysis	Consequence	Analysis
Possible	Given the rising demand for on-demand acquisition services, it's possible that the commercial market could reach saturation, leading to delays in data access, increased costs, compromised data quality, and potentially deterring new market entrants in Australia.	Australian Economy: **Moderate**	Capacity saturation for on demand acquisition could disadvantage a number of major Australian organisations or companies.
		International Relations: **Moderate**	Capacity saturation for on demand acquisition could disadvantage Australia in international negotiations or strategy where EO data access was needed but supply was not available.

Overall: **MEDIUM**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.2, B.3, B.6, B.11, B.12, B.23

3.2.3 M3: Changes to international free and open data policy reduce or impede commercial viability of EO products and services

Risk	Several of the commercial companies surveyed in Australia rely solely on EO data supplies originating with ESA and/or NASA/USGS for their commercial products that they develop and deliver to clients. All companies in the survey are using data products under a free and open data agreement in their commercial offerings. If these supply lines fail due to changes in foreign data policy (either through a move to charge for EO data or a restriction on the use of data by Australian commercial companies) it is possible these companies will go out of business if their cost model does not have sufficient margins to cover the purchase price of commercial satellite imagery.
Assessment	A number of EO products and services offered by Australian companies interviewed as a part of this study indicated that without free and open data, their value-adding business models would not be commercially sustainable. In fact, their business models are predicated on free and open data, and so they would likely not exist.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Possible	Given the reliance of many commercial EO offerings on free and open data, it is possible that changes to the distribution policy would impede the commercial viability of services currently offered.	Australian Economy: **Moderate**	Changes to free and open data policy would disadvantage a number of major Australian organisations or companies that currently rely on these services.
		International Relations: **Minimal**	Changes to free and open data would likely cause incidental damage or disruption to Australia's diplomatic relations where these services/products are utilised. A higher consequence category would occur here for the country that modified the open data policy.

Overall: **MEDIUM**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.3, B.5, B.8, B.23

3.2.4 M4: Significant downturn in the Australian economy means foreign commercial data becomes too expensive for users

Risk	Economic factors such as a pronounced downturn, or a major currency fluctuation could render foreign commercial data prohibitively expensive. This is particularly true for large area coverage, for example national or state level monitoring activities.
Assessment	Economic factors could lead to data supply disruptions. Over time, the nation's global competitiveness and ability to participate in data-driven initiatives could diminish, potentially prolonging the economic recovery period.

Likelihood	Analysis	Consequence	Analysis
Rare	It would be rare for Australia to face an economic downturn severe enough that it would challenge the nation's ability to purchase foreign commercial EO data.	Australian Economy: **Substantial**	Economic downturn in Australia, resulting in inability to access commercial EO data due to prohibitive costs or unfavourable currency exchange rates, could disrupt the financial viability of data-reliant Australian industry sectors (multiple major organisations in the same sector), and potentially hinder global competitiveness and prolonging economic recovery.
		International Relations: **Moderate**	Compromising the financial stability of an Australian industry sector, might weaken Australia's global standing and extend its economic recovery period. This may cause short-term damage or disruption to diplomatic relations.

Overall: MEDIUM

Risk Trend: Neutral

Evidence: See Appendix B Sections B.2, B.6, B.8, B.11, B.13, B.15, B.23

3.2.5 M5: Globalisation means domestic Australian EO data service providers become too expensive

Risk	EO data is a digital product, subject to global market forces, including those that are increasingly moving technical expertise and related activities to locations with more cost-effective labour markets. An example of this is the rise of platforms such as 'Fiverr', a digital marketplace that connects businesses with freelancers offering services at significantly reduced prices. Platforms resembling Fiverr, catering to EO services could provide access to low cost providers from around the globe. This could substantially undercut Australian EO service providers on price, rendering them financially unsustainable or unable to match the competitive rates, which could result in a reduction in Australia's domestic EO data supply capability.
Assessment	Globalisation could mean that domestic Australian EO data service analysis and providers become too costly and Australian companies choose to 'offshore', where they employ teams in other countries to do the work delivered to Australia. This could lead to local EO service companies becoming unviable or struggling to compete on price, potentially resulting in business closures or significant downsizing. Such a scenario would not only lead to job losses (or lack of job creation) in the sector but also diminish Australia's self-reliance and capacity to use EO data services. Over time, an over-reliance on international providers might expose Australia to geopolitical vulnerabilities, data access restrictions, and potential compromises in data quality or specificity tailored to Australian needs.

Likelihood	Analysis	Consequence	Analysis
Possible	While there is already evidence that offshoring exists in the private sector, particularly in software and processing of EO data, it is assessed as possible that it will become more commonplace. Most companies maintain an Australian team and would not be viewed at this stage as so expensive that it is necessary to go directly offshore.	Australian Economy: **Substantial**	Undermines the financial viability of an Australian industry sector, may lead to job losses and diminished national capacity and capability (multiple major organisations in the same sector).
		International Relations: **Minimal**	Limited damage to the government is minor and incidental damage or disruption to diplomatic relations.

Overall: HIGH

Risk Trend: Neutral

Evidence: See Appendix B Section B.8

3.2.6 M6: Obsolete or discontinued software and/or platforms

Risk	The risk of obsolescence or discontinuation arises when a commercial entity decides to deem a specific software or platform as outdated or chooses to cease its maintenance and support. This risks loss of access to data, in particular historical datasets, or may necessitate costly transitions to alternative solutions.
Assessment	Loss of data access due to obsolete or discontinued software and platforms is a challenge faced by major space data managers and agencies around the world. This is largely relevant for access to historical datasets, important for applications such as environmental monitoring and urban planning. This presents issues around incompatibility, hinders historical data comparisons, and may impact trend analyses. Remedies for this obsolescence can be costly, including programs to transition to new platforms or software, as well as building up the necessary skills and human resources.

Likelihood	Analysis	Consequence	Analysis
Likely	It is likely that software and/or platforms used for EO data analysis and dissemination become obsolete and are discontinued.	Australian Economy: **Moderate**	Disadvantages several major Australian organisations or companies through the cost associated with rebuilding the analysis pipeline and EO data supply restrictions to meet current client/government needs reliant on these services.
		International Relations: **Minimal**	Limited damage to the government and incidental damage or disruption to diplomatic relations.

Overall: **MEDIUM**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.16, B.17

3.3. Programmatic Risks

Programmatic risks relate to factors, uncertainties, and potential negative outcomes that could affect the structured planning, execution, and management of EO programs. These risks can lead to deviations from planned outcomes, affecting timelines, budgets, and the overall delivery of program objectives.

The programmatic risks considered in this section are summarised in Table 6.

Table 6: Programmatic Risks and Overall Ratings

Risk	Overall Rating
PR1: Reliance on international partners to select, develop, fund, and operate missions that correspond to Australian needs	**MEDIUM**
PR2: Loss of key missions due to launch failure	**LOW**
PR3: Loss of access to or significant delays in access to launch	**MEDIUM**
PR4: Foreign government priorities change, shifting space agency programs	**MEDIUM**
PR5: Sustaining Australian university capacity and support	**MEDIUM**
PR6: Australian Government program funding changes impact future key programs and infrastructure	**HIGH**
PR7: Australia's talent pool is insufficient to meet national needs	**MEDIUM**
PR8: Inability or delayed ability to respond to future data supply risks	**VERY HIGH**
PR9: Foreign government EO program designed to shift global power allegiances	**HIGH**
PR10: Key EO missions reach end of life and are not replaced with new operational missions	**HIGH**
PR11: Operational use of and dependence on research missions	**MINOR**

3.3.1 PR1: Reliance on international partners to select, develop, fund, and operate missions that correspond to Australian needs

Risk	Foreign EO data sources, such as the European Copernicus (EC) program or the US Landsat program, may not always meet the specific needs and priorities of Australia, such as the coverage, frequency, resolution, or timeliness of EO data (Deloitte, 2021). Australia has no formal influence on these program decisions and, for example, is not eligible to sit on ESA EO satellite mission advisory boards and can therefore not formally communicate Australian requirements for inclusion in funded missions.
Assessment	Relying on international partners to select, develop, fund, and operate missions means that capabilities will not necessarily be optimised for Australian needs If partner priorities shift, or if diplomatic or economic relations become strained, this could lead to EO data supply needs being unmet or inadequately addressed leading to gaps. This situation also limits influence over mission parameters, timelines, or data access rights and may be vulnerable to external geopolitical shifts.

Likelihood	Analysis	Consequence	Analysis
Possible	The priorities of development partners such as Europe and the US are currently in good alignment with Australian EO data needs. However, this is not necessarily the case as demonstrated by GA's need to generate Australian versions of analysis ready data products to date.	Australian Economy: **Moderate**	Impact is likely limited to organisations and businesses needing to shift business models due to lack of suitable data supply, e.g., insurance industry pricing, foundational datasets and algorithms.
		International Relations: **Moderate**	This could disadvantage Australia's international negotiations, for example if the data made available from foreign sources showed the Australian perspective in a negative light or focused on areas where Australia was not strong e.g., satellites focused on GHG emissions rather than progressive land use.

Overall: MEDIUM

Risk Trend: Neutral

Evidence: See Appendix B Sections B.3, B.4, B.5, B.6, B.11, B.18, B.19, B.23, B.24, B.25, B.28

3.3.2 PR2: Loss of key missions due to launch failure

Risk	This risk refers to the possibility of a rocket not successfully launching and deploying crucial satellites or spacecraft. This can arise from various causes, such as technical failures, oversight by personnel, external environmental challenges, or inherent design issues. The impact of such an event could be substantial delay to or complete loss of a new (or continuity) data stream for Australian users.
Assessment	The loss of key missions due to launch failure not only results in immediate financial losses from the investment in the mission but also delays the acquisition of critical data that these missions were intended to provide.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Rare	The launch success rate is greater than 90% with modern launchers.	Australian Economy: **Minimal**	While significant for an individual mission operator, a failure would not likely undermine the financial viability of a major Australian enterprise.
		International Relations: **Minimal**	While the disruption to a particular diplomatic interest for Australia may be significant, beyond the short-term it would not be expected to be significant.

Overall: **LOW**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.7, B.23

3.3.3 PR3: Loss of access to or significant delays in access to launch

Risk	Most foreign governmental launch capacities are already committed to their own priority launches, and demand for commercial launch slots is significant and growing. This is due to factors such as the surge in space communication satellite launches (e.g., by Starlink with others such as Amazon's Project Kuiper to follow) which has further strained the available commercial slots for EO launches. Current backlogs can be several years.
Assessment	Loss of access to, or significant delays in, launch capabilities poses a multifaceted challenge for Australia. Immediate consequences include disruptions in planned satellite deployments, which can hinder the nation's ability to gather essential EO data in a timely manner. Economically, delays can escalate costs due to contractual penalties, storage needs, or the requirement for alternative arrangements. Strategically, consistent launch access issues can erode Australia's reputation in the global space community, making collaborations or partnerships more challenging to secure. Over time, such impediments might also deter domestic investments in space technologies.

Likelihood	Analysis	Consequence	Analysis
Likely	Without any viable Australian-based orbital launchers, we are wholly dependent on foreign launch providers. The governmental launchers are generally all allocated to priority foreign launches, and the dependence on space communications has taken up almost all the commercial supply. As of 2023 if we wanted to launch a significant payload, we would be looking at a backlog of several years.	Australian Economy: **Moderate**	It is possible that the lack of access to launch could disadvantage several major Australian companies, inhibiting their ability to respond to losses or changes in satellite EO data supply in a timely manner.
		International Relations: **Moderate**	It is possible that the lack of access to launch could disadvantage Australia in international negotiations by inhibiting the ability to gather observations and evidence in a timely manner. It may also have impacts on the ability to project or implement national strategies.

Overall: **MEDIUM**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.11, B.20, B.22, B.23

3.3.4 PR4: Foreign government priorities change, shifting space agency programs

Risk	A shift in foreign governmental direction could cause disruption to supply for Australia. For example, EO may no longer be viewed as a critical area of national expenditure by foreign space agency or data provider agency. Furthermore, even if foreign governments continue investing in EO, their focus may diverge from Australian needs. This misalignment could pose challenges for Australia, especially if the type of EO data or technology it requires is no longer prioritised or developed by key international partners.
Assessment	Collaborative projects or data-sharing agreements with these agencies whose priorities have changed may be impacted, potentially leaving Australia without EO data supply. This may lead to increased costs, development of alternative partnerships, or investment in developing national capabilities to fill the void.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Possible	There are no assurances of policy alignment between Australia and foreign governments when it comes to the prioritisation of space activities, including around the importance of satellite EO or the types of EO data that are gathered.	Australian Economy: **Moderate**	Impact is likely limited to minor-major organisations and businesses needing to shift business models due to lack of suitable data supply. e.g., insurance industry pricing.
		International Relations: **Minimal**	This could disadvantage Australia at international negotiations, for example if the data made available from foreign sources showed the Australian perspective in a negative light or focused on areas where Australia was not strong. e.g., satellites focused on GHG emissions rather than progressive land use.

Overall: **MEDIUM**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.7, B.8, B.22, B.23

3.3.5 PR5: Sustaining Australian university capacity and support

Risk

Australian universities play a key role in the development and effective implementation of EO programs. They face challenges which could in time cause issues for data supply:

- The transient nature of university research staff can hinder the consistent attraction and retention of expertise necessary for these programs.
- The lack of dedicated EO-related degrees or deep specialisations creates foreign reliance.
- There is a limited pool of academic staff nationally, and a notable deficiency in promoting EO applications and study opportunities at pre-tertiary and secondary levels.
- There is a lack of multidisciplinary EO training across fields, such as biophysical, atmospheric, and geological sciences.

Furthermore, the progression from pure research to operationalisation and commercialisation of EO research is hindered by fragmented and sometimes inadequate funding, including funding scheme scope limits on partner institutions, high levels required for co-investment, restrictive intellectual property requirements, and patchy connections between researchers, industry, and government.

Assessment

The restrictions and conditions within universities could lead to a decrease in the available workforce or limited research development, reducing both the demand and ability to use EO data in Australia.

Likelihood	Analysis	Consequence	Analysis
Likely	The issues identified are relatively common across the university sector in Australia.	Australian Economy: **Moderate**	A lack of EO capacity or capability in the university sector can cause a moderate impact on a number of organisations, meaning certain opportunities are missed by industry, or that industry needs to train or hire (often overseas) their own staff to fulfil their needs.
		International Relations: **Minimal**	This issue is not likely to disadvantage Australia in negotiations or strategy, and if so, it is likely the damage will be limited.

Overall: **MEDIUM**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.19, B.28, B.32

3.3.6 PR6: Australian Government program funding changes impact future key programs and infrastructure

Risk	Investment by the Australian Government is often perceived by international partners as a commitment, indicating readiness to collaboratively fund the objectives of their EO programs. These domestic programs to support international partnerships might encompass any of the components of the space segment (e.g., satellites), the ground segment (e.g., ground stations), or the user segment (e.g., exploitation frameworks, Open Data Cube).
Assessment	The primary concern related to this risk is that a lack of or reduced funding causing reputational damage, especially with crucial international partners who are foundational to supplying data to Australia, compromising data supply.

Likelihood	Analysis	Consequence	Analysis
Likely	While not all Australian government programs have their funding cancelled, it has happened and cannot be ruled out again in future.	Australian Economy: **Moderate**	The cancellation of such funding has financial implications for companies across the Australian space sector. The impact is particularly acute for SMEs (Small and Medium Businesses) who do not generally have large legacy contracts to help offset issues with cash flow and business establishment.
		International Relations: **Substantial**	The credibility impact of the cancellation of funding for Australian government programs related to EO has called into question Australian commitment to its international partners. The doubt this has caused has led to severe disadvantages with previous partners (e.g., USGS and NASA, Japan, Europe).

Overall: HIGH

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.3, B.6, B.8, B.11, B.12, B.13, B.15, B.19, B.22, B.23, B.25, B.27

3.3.7 PR7: Australia's talent pool is insufficient to meet national needs

Risk	Significant expertise is required to work effectively with satellite EO data at all stages from upstream hardware and data supply; through downlink, ground segment, and data processing pipeline; and, on to the user segment and applications. The skills required to support such a workflow are both diverse and specialised. While institutions like Australian universities and the Technical and Further Education (TAFE) system are equipped to cultivate such talent, concerns arise regarding the adequacy and responsiveness of their efforts to meet needs across the EO industry. The risk emerges as a potential shortfall in the depth and variety of skilled professionals available for roles in government, academia, and industry. Often, to bridge this gap, there is a reliance on experts trained abroad or directly recruited from overseas.
Assessment	An insufficient talent pool could lead to implementation challenges, including operational bottlenecks, leading to reduced efficiency, productivity, and potentially compromising the quality of services or products. This talent deficit could deter international companies from investing or setting up operations in Australia, potentially leading to lost economic opportunities. Moreover, the country might become overly reliant on foreign talent, which could have implications for wage dynamics, job security, and even national security in certain sectors. A lack of skilled professionals could stifle innovation, hindering Australia's ability to compete on the global stage and adapt to emerging challenges.

Likelihood	Analysis	Consequence	Analysis
Likely	There have been past cases where the level of Australian expertise has needed to be augmented with foreign expertise to support the development of EO programs.	Australian Economy: **Moderate**	The lack of a domestic talent pool disadvantages a number of Australian organisations. This disadvantage takes the form of recruiting challenges and cost, as well as a lack of resilience to the loss of key staff members.
		International Relations: **Moderate**	The lack of a domestic talent pool disadvantages the Australian government in its efforts to recruit key personnel who can support international negotiations or the implementation of national strategy by being unable to secure the necessary capabilities.

Overall: MEDIUM

Risk Trend: Neutral

Evidence: See Appendix B Sections B.19, B.28, B.29

3.3.8 PR8: Inability or delayed ability to respond to future data supply risks

Risk	Australia currently lacks the domestic capability to develop, build, launch, or operate its own EO satellites.
Assessment	This lack of capability in Australia due to the lack of space infrastructure and workforce could have a significant impact on developing domestic future data supply, including limiting the ability to respond to future data supply risks in a timely manner. At present, Australia remains dependent on foreign expertise and capability to develop, build, launch, or operate EO systems presenting potential vulnerabilities to geopolitical shifts, data access restrictions, and missed opportunities for innovation, job creation, and industry growth in the satellite and space sectors. The lack of this capability could diminish Australia's influence in international space and satellite forums, compromising its ability to shape global EO policies and collaborations in line with its national interests.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	Domestic capability is currently low, with limited activities in place or planned to raise the level.	Australian Economy: **Substantial**	The lack of a domestic EO capability undermines the financial viability of an Australian industry sector (multiple major organisations in the same sector).
		International Relations: **Substantial**	The lack of a domestic EO capability disadvantages Australia in major international negotiations or strategy.

Overall: **VERY HIGH**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.2, B.3, B.5, B.8, B.18, B.19, B.23, B.25, B.27

3.3.9 PR9: Foreign government EO program designed to shift global power allegiances

Risk	This risk concerns the possibility of a foreign government, particularly from a country who is not currently an Australian data supplier, offering superior free and open satellite EO data (spatial, spectral, temporal resolution). If this data supply were not made available universally or globally, Australia could be excluded from potentially superior data supplies, limiting access to supplies of valuable EO data.
Assessment	The parameters of the current free and open data supply landscape were set by the opening up of Landsat (US), followed by the opening up of Copernicus (Europe) data streams. Whether or not these were conscious decisions to influence the landscape (likely), this landscape has been highly favourable to Australian interests. Given the rapid technological advancements globally, coupled with the dynamic geopolitical environment, there is a possibility that other nations or blocks may adopt similar strategies to shift the global satellite data supply market. There are no guarantees that these will also be on terms favourable to Australia, and may mean that the supply of superior quality data is not accessible for Australian users.

Likelihood	Analysis	Consequence	Analysis
Possible	Given the changing technical landscape, it seems likely that a level of reconfiguration will take place.	Australian Economy: **Moderate**	Commercial entities that provide satellite data might face severe competition, which could impact their profitability, leading to reduced investment in research, development, and innovation in this sector. As commercial satellite providers suffer, there could be potential job losses in this industry and reduced incentive for new players to enter the market.
		International Relations: **Substantial**	The reliance on external high-resolution satellite data might pose national security risks if that data is suddenly withheld or if it is manipulated to hide or fabricate information.

Overall: HIGH

Risk Trend: Neutral

Evidence: See Appendix B Sections B.5, B.6, B.8, B.18, B.23

3.3.10 PR10: Key EO missions reach end of life and are not replaced with new operational missions

Risk	In some cases, EO data supply missions that applications depend on may not be replaced at their end of life. This could be because of a premature end of life, or it could be because a program has ended or taken a different path.
Assessment	Missions reaching the end of life without being replaced by definition create data gaps. In cases where Australia has little or no influence over these program decisions, there is a level of risk to data supply and service continuity. This has happened in the past, and should be expected to happen again in the future.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	Key missions have already reached end of life and/or are in the process of being decommissioned. They have either not been replaced with a new mission, or users of the data have not yet updated their workflows to use an alternative data source, because there is no alternative available.	Australian Economy: **Moderate**	Damage undermining the financial viability of a major Australian-based or owned organisation or company is likely to occur if critical satellite image products are not available.
		International Relations: **Moderate**	There will be impacts on international relations where Australia may provide services to other countries, and these are disrupted due to the data no longer being available from the satellite.

Overall: HIGH

Risk Trend: Neutral 

Evidence: See Appendix B Sections B.5, B.7, B.8, B.18. B.24, B.25

3.3.11 PR11: Operational use of and dependence on research missions

Risk	It is common for new satellite data applications to be developed using data from one-off research type missions, rather than operational sources. By definition, these sources don't plan continuity which presents an inherent data supply risk. Despite this, operational services utilise data streams from research missions, for example MODIS which is ending as of 2023.
Assessment	This is a common scenario in research, as well as application development, and it can be expected to continue into the future. Because NASA does not develop operational missions, any data from NASA EO satellites is inherently one-off. The same applies for ESA's Explorer missions, including key missions such as the TRUTHS calibration-validation satellite. This approach to application development is a part of the technology development cycle, however it does carry with it a level of data supply risk.

Likelihood	Analysis	Consequence	Analysis
Possible	Research projects utilise available data possibly without consideration of the potential loss of future access to the same data source or an equivalent successor. The data source is often a research mission without a successor.	Australian Economy: **Minimal**	While perhaps important for the research project, this issue is not likely to undermine the financial viability of one or more individuals, minor Australian-based or owned organisations or companies.
		International Relations: **Minimal**	This issue is not likely to disadvantage Australia in negotiations or strategy, unless the research and operation is/would be beneficial to other nations.

Overall: **MIN OR**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.1, B.3, B.8, B.24

3.4. Environmental Risks

Environmental risks are concerned with the potential disruptions or damages to satellite operations caused by space weather and other orbital conditions. This includes phenomena that can impact the satellites' capabilities to collect, transmit, and process EO data, and ultimately the reliability of data supply.

The environmental risks considered in this section are summarised in Table 7.

Table 7: Environmental Risks and Overall Ratings

Risk	Overall Rating
E1: Space debris collision destroys satellite	**MINOR**
E2: Collision or series of collisions of other spacecraft degrade orbital environment or render it unusable and impact satellite performance and reliability	**MEDIUM**
E3: Solar flare impacts spacecraft performance, lifetime or context	**MEDIUM**
E4: Communications uplink/downlink disrupted	**MINOR**
E5: Terrestrial frequency interference	**MINOR**

3.4.1 E1: Space debris collision destroys satellite

Risk

There is a growing risk associated with the congestion in Low Earth Orbit (LEO). As more satellites and debris populate this orbital region, the environment becomes increasingly contested. Such congestion poses challenges for EO satellite operators, as the crowded space could limit their operational flexibility and potentially obstruct their activities in orbit.

The direct impact of a space debris collision with an EO satellite, could lead to its complete destruction, resulting in a total loss of its capabilities and functions. The increasing congestion of space debris poses a growing threat to operational satellites, jeopardising their functionality and the investments behind them.

Assessment

As LEO becomes more crowded, the risk of collisions or close encounters between satellites increases, potentially endangering both existing assets and future satellite deployments. A collision with space debris resulting in the destruction of a satellite could have profound implications for Australia. Immediately, there would be a loss of vital services and data provided by the satellite, affecting sectors ranging from communication and navigation to weather forecasting and national defence. This could lead to operational disruptions, compromised safety, and potential economic losses. Moreover, the financial cost of replacing the satellite, coupled with the time lag in deploying a new one, could strain national resources. Such an incident could also undermine confidence in Australia's space capabilities, potentially affecting international collaborations or partnerships. On a broader scale, the increasing threat of space debris could necessitate more stringent satellite design and launch protocols, escalating costs and complicating future space missions. In the long run, ensuring the safety and functionality of space assets amidst growing space debris challenges could become a significant concern.

Likelihood	Analysis	Consequence	Analysis
Unlikely	Direct collisions of satellites in Earth orbit have occurred. However, they are not very common, and with the risk in the number of satellites in orbit increasing attention is being paid to both traffic management and orbital debris management. Despite these efforts, the likelihood should be considered to be increasing.	Australian Economy: **Minimal**	While such a collision could have significant impact on the viability of a single data provider, the impact of the loss of one satellite is unlikely to cause widespread consequences. This will increase the overall debris environment in orbit, and that is addressed in risk E2.
		International Relations: **Moderate**	While the loss of a key data supply may present some minor issues to Australian government strategy or negotiations, if such a collision involved an Australian satellite, and if the other satellite(s) in the collision represented significant capacity for another nation, this may lead to a short-term diplomatic situation to be managed.
Overall:		**MIN OR**	

Risk Trend: Increasing

3.4.1 E1: Space debris collision destroys satellite

Evidence: See Appendix B Sections B.9, B.23

3.4.2 E2: Collision or series of collisions of other spacecraft degrade orbital environment or render it unusable and impact satellite performance and reliability

Risk	A risk emerges from potential collisions in space that can deteriorate or render unusable the orbital environment. Such degradation could compromise a satellite's operational capabilities, necessitating temporary or permanent evasive actions. These manoeuvres might subsequently diminish the satellite's performance, such as resolution or revisit capabilities, or curtail its mission lifespan due to additional fuel expenditure. In an extreme case the orbital environment may be rendered unusable, causing a temporary or even permanent halt in supply of EO data from space. While the complete loss of the orbital environment is unlikely, the ensuing mitigation costs could reach a point where addressing the issue becomes technically or economically impractical, given the nature of required countermeasures
Assessment	Orbital degradation would compromise an EO satellite's operational capabilities, necessitating either temporary or permanent evasive actions. These can diminish the satellite's performance, such as resolution or revisit capabilities, and curtail mission lifespan due to additional fuel expenditure. If the orbital environment is rendered unusable society could face temporary or permanent supply stoppages of satellite data and services.

Degradation case

Likelihood	Analysis	Consequence	Analysis
Possible	A number of analyses have suggested that a single collision (while unlikely) could lead to a cascading series of collisions which leads to widespread contamination of the orbital environment.	Australian Economy: **Moderate**	In the context of EO the degradation of the orbital environment would disadvantage a number of Australian organisations and companies. This could be in the form of a lesser capability delivered from EO, or from greater spacecraft engineering costs required to deliver the same capability. It should be noted that the impact on important non-EO systems such as GPS/GNSS and communications is not factored into this assessment - however it should be assumed that this would only increase the impact.
		International Relations: **Moderate**	In the context of EO the degradation of the orbital environment would disadvantage Australia in the implementation of any national strategy related to EO. This would manifest as degraded or more expensive program budgets. In more extreme cases, this could call into question the overall viability of EO from space - as such this should

3.4.2 E2: Collision or series of collisions of other spacecraft degrade orbital environment or render it unusable and impact satellite performance and reliability

be considered an increasing risk.

Overall:	**MEDIUM**
Risk Trend: Increasing	
Evidence: See Appendix B Section B.9	

Unusable orbit case

Likelihood	Analysis	Consequence	Analysis
Unlikely	A number of analyses have suggested that a single collision (while unlikely) could lead to a cascading series of collisions which leads to widespread contamination of the orbital environment.	Australian Economy: **Substantial**	The loss of EO from space would have a substantial impact on the Australian economy. For example, EO from space is a key input to the insurance industry's pricing model as well as the detailed assessment of mineral resources for discovery and exploitation. It should be noted that the impact on important non-EO systems such as GPS/GNSS and communications is not factored into this assessment - however it should be assumed that this would only increase the impact.
		International Relations: **Substantial**	The loss of EO from space would have a substantial impact on international relations in several ways. The loss of transparency provided by satellite EO would increase uncertainty and raise international tensions. Such a loss would also severely disadvantage Australia in the implementation of a strategy of technological superiority to amplify the impact of our relatively small population.

3.4.2 E2: Collision or series of collisions of other spacecraft degrade orbital environment or render it unusable and impact satellite performance and reliability	
Overall:	**MEDIUM**
Risk Trend: Increasing	
Evidence: See Appendix B Section B.9	

3.4.3 E3: Solar flare impacts spacecraft performance, lifetime or context

Risk

Solar flares affecting spacecraft functionality, or their operational context have the potential to degrade or even disable individual or multiple satellites. The repercussions of these solar disturbances can manifest in numerous ways, ranging from a complete loss of service to compromised operations necessitated by orbital adjustments. Furthermore, the performance of the affected spacecraft might deteriorate due to damage inflicted by the solar flare. This poses challenges to maintaining consistent and reliable EO capabilities from space.

There is an inherent risk associated with heightened solar activity leading to increased drag on satellites. This systematic risk is driven by solar cycles that amplify drag effects on satellites over periods of approximately 10 years. While it is conceivable to design satellites to withstand these cycles, the recent surge in 'small satellite' deployments, particularly in lower orbits ranging from 300-500 km, complicates matters. Many of these satellites were launched during the most recent period of low solar activity. As a result, some operators may have based their mission strategies and business plans on assumptions that might not hold true during periods of increased solar activity, posing challenges to satellite longevity and functionality.

Assessment

The likelihood and consequence of a solar flare impacting an individual satellite is thought to be minimal, however, the nature of solar flares means their impacts are generally more widespread, with the potential to impact the entire fleet of Earth orbiting satellites in extreme cases. This would include EO satellites, as well as all other satellites (e.g., GPS/GNSS, communications, human spaceflight). Both cases are analysed separately below.

Increased solar activity could affect the orbital stability and lifespan of satellites, requiring more frequent adjustments to maintain their designated orbits. This could lead to faster depletion of onboard fuel reserves, potentially shortening the operational life of the satellites. The immediate implications might include disruptions in services provided by these satellites, spanning areas like telecommunications, GPS navigation, weather forecasting, and national defence. Additionally, data accuracy and reliability might be compromised, affecting various sectors that rely on precise satellite data.

Solar flare impacts a single spacecraft

Likelihood	Analysis	Consequence	Analysis
Unlikely	There is evidence that solar flares have impacted spacecraft performance and lifetime in the past. While these events are not common, they can have significant impact on a spacecraft and are likely to occur with little or no warning.	Australian Economy: **Minimal**	While the loss or shortened life of a satellite to a solar flare could have a significant impact on an individual company or operator, the overall damage to the Australian economy is thought to be minimal.
		International Relations: **Minimal**	While the loss or shortened life of a satellite to a solar flare could have a significant impact on an individual company or operator, the overall damage to Australian security is thought to be minimal.

3.4.3 E3: Solar flare impacts spacecraft performance, lifetime or context

Overall: MINOR

Risk Trend: Neutral 

Evidence: See Appendix B Section B.21

Solar flare impacts a large number of spacecraft

Likelihood	Analysis	Consequence	Analysis
Rare	There is evidence that solar flares have impacted spacecraft performance and lifetime in the past. While these events are not common, they can have significant impact on a spacecraft and are likely to occur with little or no warning.	Australian Economy: **Substantial**	A generalised loss of EO satellite capabilities could undermine the financial viability of major Australian companies such as insurers and miners. If consideration is extended to a complete loss of all satellite capabilities (e.g., GPS/GNSS, communications), then this would present a **Substantial** impact in terms of sectoral issues, as well as long-term damage.
		International Relations: **Substantial**	The loss of EO from space would have a substantial impact on international relations in several ways. The loss of transparency provided by satellite EO would increase uncertainty and raise international tensions. Such a loss would also severely disadvantage Australia in the implementation of a strategy of technological superiority to amplify the impact of our relatively small population.

Overall: MEDIUM

Risk Trend: Neutral 

Evidence: See Appendix B Section B.21

3.4.4 E4: Communications uplink/downlink disrupted

Risk	A risk exists in the form of disruptions or degradations to satellite communications beyond what is typically expected in regular operations. Such interruptions could affect both the uplink, essential for command and control, and the downlink, vital for data retrieval. The root causes of these disruptions might be varied, ranging from intentional jamming attempts to inadvertent interferences from competing spacecraft and users. The implications of such disturbances can potentially compromise the satellite's ability to function effectively and deliver critical data.
Assessment	Disruption of communication uplink/downlink frequency could impede the seamless transfer of data between satellites and ground stations. Critical sectors could face operational challenges due to delayed or lost signals. For businesses, especially those that depend on real-time data or communication, such disruptions could lead to financial losses and compromised client relations. On a broader societal level, interruptions in communication links could hinder emergency response efforts, potentially jeopardising public safety during crises. Furthermore, consistent disruptions might undermine confidence in Australia's technological infrastructure, potentially affecting international collaborations and investments. In the long term, Australia might need to invest in redundant communication systems or advanced technologies to ensure resilience against such disruptions.

Likelihood	Analysis	Consequence	Analysis
Unlikely	This kind of disruption is not common (outside of normal operational interruptions). If systems are designed with correct security, redundancy, and resilience, it should not be expected.	Australian Economy: **Minimal**	Loss of communications with a single satellite may undermine the financial viability of a business, but the consequence is unlikely to be far reaching.
		International Relations: **Moderate**	Loss of communications with a single satellite may cause some limited damage to an individual government activity, but the direct consequence is unlikely to be far reaching. If the loss of communications is due to a malicious actor, depending on the nature of this actor, it could lead to short-term damage or disruption to diplomatic relations.

Overall: **MIN OR**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.10, B.11, B.16, B.21, B.22, B.27

3.4.5 E5: Terrestrial frequency interference

Risk	Terrestrial (i.e., ground-based) frequency interference can interfere with satellite communications. For instance, radar imaging bands, crucial for satellite operations, could experience disruptions from terrestrial communications like 5G networks. Another example includes interference from optical lasers emanating from the Earth's surface. Such interferences can compromise the quality of satellite data and impact the overall effectiveness of space-based operations.
Assessment	Terrestrial frequency interference with EO data capture can degrade the quality of data collected by satellites, leading to inaccuracies in the information used for various applications. This could result in inefficient resource allocation, misguided policy decisions, or delayed responses in emergency situations. For the scientific community, research relying on EO data might be hindered, potentially affecting studies related to climate change, land use, and more. Economically, industries that depend on accurate EO data could face operational challenges, leading to financial setbacks. Furthermore, consistent interference issues might erode trust in Australia's EO capabilities, affecting both domestic confidence and international collaborations. In the long run, addressing such interference might necessitate investments in advanced satellite technologies or regulatory measures to manage and mitigate terrestrial frequency emissions. Certain bands may be lost completely to EO as frequency bands get congested or reassigned for different sectors.

Likelihood	Analysis	Consequence	Analysis
Possible	P-Band radar satellites (the first of which will be launched in 2024) are unable to image large parts of the world due to interference with national defence systems. X-Band radar imagers also experience interference with frequencies allocated to terrestrial 5G satellites. S-Band systems experience interference from modern car parking aid systems.	Australian Economy: **Minimal**	The impact to the economy is likely to be minimal, perhaps impacting smaller data provider organisations or possibly the application of certain observational techniques in certain parts of the world.
		International Relations: **Minimal**	The impact to international relations is likely to be minimal, perhaps impacting certain observational techniques in certain parts of the world.

Overall: **MIN OR**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.10, B.16, B.27

3.5. Technical Risks

Technical risks involve the potential for disruptions, inaccuracies, or failures in the technological processes underpinning the collection, transmission, or processing of satellite data. This includes how technological challenges, malevolent or negligent acts, or system malfunctions could interrupt or degrade the quality and flow of EO data.

The technical risks considered in this section are summarised in Table 8.

Table 8: Technical Risks and Overall Ratings

Risk	Overall Rating
T1: Failure or degradation of onboard systems leads to degraded or lost capability	MINOR
T2: Ground segment systems failure	MINOR
T3: Inability to independently verify satellite EO data provenance including data spoofing and tampering	HIGH
T4: Inadequate training data to drive future AI uptake in Australia and/or other collaborating countries	MEDIUM
T5: Insufficient or inconsistent calibration data or approaches	MEDIUM
T6: Inconsistent processing of Analysis Ready and derived data products	MINOR

3.5.1 T1: Failure or degradation of onboard systems leads to degraded or lost capability

Risk	There is a risk of onboard satellite system malfunctions leading to diminished operational capabilities. These onboard systems span a variety of components, from instruments and optics to data and processing systems, as well as communication, storage, power, propulsion, mechanical systems, and software. A malfunction or deterioration in any of these crucial systems can result in compromised satellite functions. Rather than a complete cessation, as with risk T2, the satellite might operate at a reduced efficiency or face intermittent disruptions, impacting the quality and reliability of its services. Satellites failing to achieve their expected design life span may lead to interruptions in coverage.
Assessment	Satellite units not reaching their expected design life would disrupt the consistent flow of EO satellite data for critical services that rely on EO data, resulting in gaps in the EO time series and periods where the data is unavailable when required. This could result in poor decision-making, cause inefficient resource allocation, hinder monitoring activities mandated by policy and international obligations, and delay emergency responses, potentially causing extensive damages, health issues, and even loss of life. The need to replace satellites outside the planned time, may divert resources from other projects to build replacement satellites. Longer term this may necessitate investments to improve satellite durability and the establishment of backup systems for continuous data coverage.

Likelihood	Analysis	Consequence	Analysis
Possible	It is possible that onboard systems for EO satellites will fail and lead to the loss of capability, and potentially interrupt EO data supply.	Australian Economy: **Minimal**	The impact of an onboard system failure leading to loss of capability could undermine the financial viability of one or more individuals, minor Australian based or owned organisations or companies.
		International Relations: **Minimal**	Onboard system failure leading to loss of capability is likely to only cause limited damage to government and incidental damage or disruption to diplomatic relations.

Overall: **MIN OR**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.7, B.9, B.18, B.21

3.5.2 T2: Ground segment systems failure

Risk	Failure of ground segment systems in satellite operations encompasses potential technical glitches in ground-based data uplink or downlink systems and antennas. Additionally, the data handling infrastructure, software, and the entire product production pipeline might also be susceptible. Such malfunctions within the ground segment can critically hinder the seamless flow of satellite data, potentially affecting a wide range of services and applications.
Assessment	Ground segment systems, which include ground stations, communication infrastructure, and data processing centres, play a pivotal role in receiving, processing, and disseminating satellite data. A failure would disrupt the flow of crucial satellite information. This could lead to data blackouts or delays, compromising timely decision-making and potentially resulting in inefficient resource allocation or delayed emergency responses. Failure could occur for a variety of reasons including physical damage (vandalism, natural disasters, accidental), software failures, hardware malfunction or cyber-attacks. The costs associated with restoring or replacing the affected ground systems could be substantial. Australia plays a critical role globally in providing ground segment infrastructure. Any failures, particularly if they lead to delays in service or failure at critical junctures, would affect the reputation, both domestically and internationally, potentially affecting future collaborations, partnerships, and investments. Over the long term, recurrent ground segment system failures might necessitate significant investments in infrastructure upgrades, enhanced maintenance protocols, and the development of redundant systems to ensure uninterrupted operations.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Possible	It is possible that ground segment systems fail for a variety of reasons.	Australian Economy: **Minimal**	The impact of ground segment system failure could undermine the financial viability to one or more individuals, minor Australian based or owned organisations or companies.
		International Relations: **Minimal**	Ground system failure leading to loss or degradation of capability is likely to only cause limited damage to government and incidental damage or disruption to diplomatic relations.

Overall: **MIN OR**

Risk Trend: Neutral

Evidence: See Appendix B Sections B.9, B.22, B.27

3.5.3 T3: Inability to independently verify satellite EO data provenance including data spoofing and tampering

Risk

With the advent of sophisticated artificial intelligence (AI) technologies, it is now possible to enhance images to resolutions up to tenfold greater than their original quality, simulate EO images from underlying map data (like Google Maps or Open Street Maps), and even entirely fabricate EO images, akin to deep fakes. These fabricated images might display misleading information, potentially leading to ill-informed decisions, especially in areas like national security or defence. This distortion from reality is further exacerbated by rising cybersecurity threats, where EO data might be intentionally manipulated. In such a complex landscape, verifying the authenticity, source, and integrity of satellite EO data becomes crucial. Failing to confirm the legitimacy of this data might jeopardise informed decision-making and undermine the credibility of the insights derived.

Assessment

The credibility of agencies and organisations may be undermined if the provenance of EO data is unable to be independently verified and trust in the satellite data's authenticity diminishes, particularly as image manipulation becomes easier with advances in AI. If EO data was manipulated, and there was no mechanism to detect this, it could cause wide ranging effects across multiple sectors due to misleading end-users.

For example, environmental monitoring, essential for addressing issues like deforestation or climate change, can be misled by manipulated EO data. From a national security perspective, inaccurate imagery can misguide intelligence agencies, leading to potential escalations, resource misallocation, and overlooked threats. Economically, it could sway global markets, affecting commodity prices and stock values based on misrepresented production levels in sectors like agriculture or energy. In times of natural disasters, it could hamper effective response efforts, exacerbating the impact on affected communities.
It will also cause difficulties in training machine learning models, which rely on accurate input training data.

Likelihood	Analysis	Consequence	Analysis
Almost Certain	The rapid advancement of AI and deep fake technologies has made the manipulation of satellite EO data increasingly feasible, heightening the likelihood of encountering tampered imagery. As cybersecurity threats continue to evolve, the probability of malicious actors exploiting these vulnerabilities to distort or falsify satellite data for strategic gain grows significantly and is almost certain to occur.	Australian Economy: **Moderate**	The inability to verify EO data provenance could disadvantage a number of major Australian organisations or companies.
		International Relations: **Moderate**	If EO data provenance cannot be independently verified it could cause short-term damage or disruption to diplomatic relations.

Overall: **HIGH**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.10, B.22, B.27, B.31

3.5.4 T4: Inadequate training data to drive future AI uptake in Australia and/or other collaborating countries

Risk	The shortage of adequate training data essential for the advancement of AI, hampers the development of novel machine learning algorithms tailored for Australia and also impedes the effective adaptation of algorithms developed overseas to cater to Australian conditions and specifications. This gap could stifle AI-driven innovation and adaptation in the region, potentially compromising the benefits of AI technologies in various applications.
Assessment	Without adequate training data, AI models might produce inaccurate or biased results, leading to misguided decisions and strategies. It could hamper the development and efficiency of AI-driven solutions, which are increasingly pivotal in the use of EO data. Additionally, the lack of comprehensive training data might force Australian entities to rely on foreign AI solutions, which do not meet the needs of the Australian market (or are not accurate under conditions in Australia). Inadequate training data could also stifle Australia's potential to harness AI for societal benefits derived from using EO, from climate change to weather prediction and environmental or production monitoring.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Likely	Accessing adequate and accurate training data for AI with EO is an ongoing issue. It is likely that training data will be inadequate, but still be used to train models.	Australian Economy: **Moderate**	The inability to obtain adequate training data for EO models could disadvantage a number of major Australian organisations or companies, where these companies are unable to develop the information products they need for decision making, or where products are inaccurate and cause the incorrect decision to be made.
		International Relations: **Moderate**	If data used to train EO models is inadequate it could cause short-term damage or disruption to diplomatic relations.

Overall: **MEDIUM**

Risk Trend: Increasing

Evidence: See Appendix B Sections B.10, B.19, B.31

3.5.5 T5: Insufficient or inconsistent calibration data or approaches

Risk	This risk refers to the lack of availability or use of either on-orbit or vicarious calibration data (ground targets) to calibrate EO images acquired from diverse sources. There is currently no uniform standard on what calibration data to use and the procedures to follow. While international space agency missions are typically well calibrated, they are not necessarily routinely cross-calibrated with other missions. Commercial missions use a range of calibration procedures. Due to the large variety of calibration procedures used, EO imagery from diverse sources cannot be readily used together for applications where consistent spectral response is required, unless rigorous cross calibration methods are used (e.g. time series analysis). Even when sensor specific corrections such as top of atmosphere reflectance and surface reflectance corrections are used there are still incompatibilities between the values from images obtained from different satellite missions, without further adjustments. Without correction this will lead to inconsistencies and inaccuracies with derived metrics, and incompatibilities with algorithms derived from a single satellite EO image source (i.e., algorithms will not work accurately when applied to EO imagery from a satellite mission different from the data source on which they were originally developed).
Assessment	The inability to harmonise diverse EO data sources can diminish the value and potential of satellite EO. Without proper calibration, integrating and comparing data from different sources becomes problematic, potentially leading to inaccurate analyses and conclusions. For instance, in agriculture, miscalibrated data might result in incorrect assessments of soil health or crop yields, leading to suboptimal resource allocation. Similarly, in environmental monitoring, discrepancies in data can hinder the accurate tracking of phenomena like deforestation or greenhouse gas emissions. In the event of natural disasters, the inability to integrate data from various sources can compromise the efficiency and effectiveness of response efforts. Furthermore, the lack of calibrated data can impede research initiatives, as scientists and researchers might struggle to combine datasets for comprehensive studies. Economically, this could lead to wasted investments in satellite missions if their data cannot be effectively integrated with other sources.

Likelihood	Analysis	Consequence	Analysis
Likely	It is likely that there will be insufficient or inconsistent calibration data impacting the use of diverse sources of EO data simultaneously.	Australian Economy: **Minimal**	Insufficient calibration data could undermine the financial viability of one or more individuals, minor Australian based or owned organisations or companies.
		International Relations: **Minimal**	Insufficient calibration data is likely to cause limited damage to government and incidental damage or disruption to diplomatic relations.

Overall: **MEDIUM**

Risk Trend: Increasing 

Evidence: See Appendix B Sections B.10, B.15, B.16, B.17, B.18, B.31

3.5.6 T6: Inconsistent processing of Analysis Ready and derived data products

Risk	Satellite image vendors typically use different descriptions of data processing levels, and it is not possible to automatically compare the processing level description between them. They also use different methods for checking and correcting data, particularly with geometric corrections. Images supplied as analysis ready may need to be further corrected before use. Over time, improvements may also be made to the processing method, and EO image archives reprocessed using the updated method (i.e., reprocessing of Landsat products means the currently available images have different values to those in previously processed Landsat collections). If the end-user is unaware of this, they may not apply further processing, have either erroneous results or conclude that the data is not fit for purpose. Due to the variety of EO data and derived products there is no consistent definition that can be applied across all imagery, and end-users need a level of expertise to make this assessment for each data source that they use. Similar concerns apply to consistency of processing of EO derived data products. Plant biomass products are a good example of this, with biomass derived products produced from both a variety of instrument types as well as using a variety of methods. Intercomparison studies have shown that these products are not consistent with each other, i.e., they report different biomass levels at the same location and time. Issues arise in the application of these derived products to decisions. For example, biomass is used as a measure of carbon storage, and inconsistent processing could lead to incorrect reporting of carbon emissions, under- or over-valuation of carbon credits, or inaccurate assessment of restoration efforts against environmental management plans.
Assessment	If satellite image vendors deliver analysis-ready images and derived data products with inconsistent processing, it could lead to unreliable or skewed analyses, potentially compromising decision-making processes across various domains. Furthermore, it could necessitate additional time and resources for recalibration and data harmonisation, increasing operational costs. This inconsistency might erode trust in satellite data products, prompting users to seek alternative data sources, reducing the growth of the EO industry in Australia.

Likelihood	**Analysis**	**Consequence**	**Analysis**
Possible	It is possible that inconsistent processing of satellite images occurs for analysis ready images and data products.	Australian Economy: **Minimal**	Inconsistent EO image processing could undermine the financial viability of one or more individuals, minor Australian based or owned organisations or companies.
		International Relations: **Minimal**	Inconsistent EO image processing could cause limited damage to government and incidental damage or disruption to diplomatic relations.
Overall:		**MIN OR**	

Risk Trend: Neutral

Evidence: See Appendix B Sections B.10, B.15, B.16, B.17, B.26

4. Discussion and Conclusions

During the course of the study, a total of 39 risks were identified and analysed across the five risk categories considered (Table 9).

Table 9: Total risks count by category

Category	Count
Policy	11
Market	6
Programmatic	11
Environmental	5
Technical	6
Total	**39**

These risks were analysed against consequences for each of the two 'impact categories' - Australian economy, and international relations. Based on this analysis, a simple weighted ranking based on the count of risk rating levels by category shows the highest risk rating for the *policy* category, and the lowest risk rating for the *environmental* category.

*Table 10: Total risks count by category and risk rating sorted by simple weighting**

Risk Rating	Policy	Programmatic	Market	Technical	Environmental
Very High	**5**	**1**	**0**	**0**	**0**
High	**3**	**3**	**1**	**1**	**0**
Medium	**3**	**5**	**5**	**2**	**2**
Minor	**0**	**1**	**0**	**3**	**3**
Low	**0**	**1**	**0**	**0**	**0**
Simple Weighting*	**4.2**	**3.2**	**3.2**	**2.7**	**2.4**

** Simple weighting calculated by assigning 5 points to very high, 4 to high, 3 to medium, 2 to minor, and 1 to low; summing those, and dividing by the total number of risks per category.*

The relatively high weighting for policy risks is reflective of Australia's dependence on foreign sources of EO. These sources of data supply are heavily invested in by foreign governments and companies, are technically advanced, and - based on current data policy settings internationally - are accessible. The assessment of supply risks shows a sensitivity to data policy changes, as well as the very high risk of a loss of data supply should one of these risks eventuate.

Of the six risks rated 'very high', all were rated with a likelihood of 'almost certain', which is characterised in Section 2 as: *"Expected to occur in most circumstances"*. If any one of these were to be realised, the consequence for EO data supply could be substantial, including the inability for the government and the commercial sector to access data for critical services across government, and industry.

Table 11: Number of risks for each risk rating

	Consequence					
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe	Total
Almost certain	0	0	2	6	0	8
Likely	0	2	6	1	0	9
Possible	0	5	6	5	0	16
Unlikely	0	0	2	1	0	3
Rare	0	1	0	2	0	3
Total	0	8	16	15	0	39

Risk levels: Low, Minor, Medium, High, Very High

For each of the six very high risks, a mechanism for their realisation and examples were identified.

Table 12: Six risks evaluated as 'Very High'

Risk	Overall Rating	Mechanism and Example
PO1: Foreign government open/free data or distribution policy change	**VERY HIGH** *Almost Certain*	**Data policy change** *2018 US National Geospatial Advisory Committee (NGAC) considered concerns over continued free and open data*
PO2: Foreign government acquisition strategy change	**VERY HIGH** *Almost Certain*	**De-prioritisation of Australian Acquisitions** *During Sentinel-1B failure, Europe is prioritised*
PO4: Change in foreign partner government policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs	**VERY HIGH** *Almost Certain*	**Loss of partner leadership** *Downgraded plans for NASA next-generation AOS climate mission*
PO6: Lack of binding data supply agreements with key providers leads to sudden demise of supply	**VERY HIGH** *Almost Certain*	**Sudden change in supply arrangements** *MOU insufficient to prevent loss of free and open supply of ALOS data*
PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension	**VERY HIGH** *Almost Certain*	**Significant conflict changes priorities** *Duty cycle clashes (e.g. NovaSAR-1 with Philippines partner) could be mirrored and amplified by other systems during conflict*
PR8: Inability or delayed ability to respond to future data supply risks	**VERY HIGH** *Almost Certain*	**Struggling to adapt to supply shock** *Lack of proven track record for building or procuring domestic replacement systems*

PO risks = Policy; PR risks = Programmatic

A further six risks which were rated as high with substantial *'serious damage'*.

Table 13: Risks evaluated as 'high' with substantial consequences

Risk	Overall Rating	Example Consequences
PR6: Australian Government program funding changes impact future key programs and infrastructure	**HIGH**	*Credibility impact of cancelled or degraded funding with international partners has led to substantial disadvantages with previous partners (e.g. USGS and NASA, ESA)*
PO3: Foreign government exercise shutter or export controls for strategic, market or tactical reasons	**HIGH**	*A change in foreign government shutter control policy could substantially disadvantage Australia commercially or weaken international position*
PO5: Poor Australian burden-sharing leads to data providers not willing to provide free data to Australia	**HIGH**	*Partner questions over commitment to EO funding following recent program decisions*
PO7: Change to WMO data policy or country participation	**HIGH**	*A change in foreign government policy around data contributions to the WMO system*
M5: Globalisation means domestic Australian EO data service providers become too expensive	**HIGH**	*Undermining the financial viability of an industry sector, leading to job losses and diminished national capacity and capability*
PR9: Foreign government EO program designed to shift global power allegiance	**HIGH**	*Reliance on foreign high-resolution satellite data might pose national security risks if that data supply is suddenly withheld*

PO risks = Policy; PR risks = Programmatic

Of the six very high rated risks, two were deemed to have increased since the previous risks report that was published in 2015, and are likely to continue increasing in the future.

Table 14: Risks evaluated as 'very high' with risk increasing

Risk	Overall Rating	Nature of Increase
PO2: Foreign government acquisition strategy change	**VERY HIGH** *Increasing*	*Foreign partners have prioritised their national needs for acquisition plans and caused supply constraint for Australia*
PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension	**VERY HIGH** *Increasing*	*Increases in regional conflicts in 2022-2023 have increased the demand for EO satellite data in these regions, reducing supply for other regions due to system capacity constraints*

Based on the study, several conclusions can be drawn.

1. All of 'very high' risks have a likelihood of '*almost certain*'. These should represent the top priority risks when considering mitigations.

2. Dependence on foreign data suppliers, coupled with a lack of binding supply agreements, means data supply could be disrupted by data policy decisions out of the control of Australian users and the Government, and potentially on very short notice. In particular, data supply from Landsat and the Copernicus Sentinel missions could be impacted by a unilateral foreign government decision (as in the case of Japan's ALOS mission).

3. The potential for geopolitical instability, and a changing geopolitical landscape compound the risks around data policy changes. This instability has influenced the boundaries and norms around what is considered contested, and has the potential to lead to changes in data access conditions.

4. The lack of a track record of building or procuring domestic EO satellites calls into question the ability for Australia to respond to data supply shocks, and this further compounds risks to supply.

5. The emergence of new commercial data providers increases both supply options and capabilities, as well as increases uncertainty in the future quality and continuity of data supply. The interplay between government and commercial EO providers (in particular new entrants, SMEs) is still unfolding, with significant changes in national policy and practice in some space data provider countries. Examples include India where the government is seeking to stimulate the national space industry and may require ISRO (the national space agency) to have a sponsor for each future national EO mission, with the prospect of competition with industry. In the US, commercial data providers are starting to provide key inputs to government services (e.g. Spire is providing satellite inputs to national weather data supply streams).

6. Space environmental risks are not insignificant, in particular around the potential for a degraded orbital environment due to debris, or natural disasters such as solar flares. While discussed, these events have not yet been experienced to date on a large scale, and thereby represent prospective 'black swan' events - unprecedented in their nature and impact. These risks did not rate as highly, but these nonetheless warrant contingency planning, in particular as reliance on EO and other services from orbit increase.

7. Three key technical risks currently rated medium (T4 training data, T5 calibration and validation) to high (T3 data provenance) are increasing over time. These are all related to the increasing integration of EO data products into the digital economy, and are subject to significant forces of change from the broader internet and cyberspace. Given the rapid, and often disruptive and non-linear changes in the broader technology space, these risks warrant close monitoring. This may include malevolent acts (e.g., cyberattack), and a loss of the ability to discern or verify the provenance of imagery from satellites due to growing capabilities around 'deep fakes' and AI.

8. The current relative abundance of EO satellite data results in an overarching risk of complacency. The risks identified in this report point to geopolitical, technological, and economic dynamics which have the potential to alter the free and open data landscape. A proactive approach is essential to ensure a resilient and sustainable supply of EO data.

The consequences are significant, with a high and increasing government and economic dependence on EO as critical infrastructure. Many dependencies have been built into the Australian economy, government services, and industry, and this heightens the impact of potential data supply risks.

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Appendices

Appendix A: List of Acronyms, Abbreviations and Table of Selected Missions and Instruments

List of Acronyms

Acronym	Expansion
AI	Artificial Intelligence
ANGSTT	Australian National Ground Segment Technical Team
AOGEO	Asia-Oceania Group on Earth Observations
AOS	Atmosphere Observing System (NASA)
APEC	Asia-Pacific Economic Corporation
APRSAF	Asia-Pacific Regional Space Agency Forum
ARC	Australian Research Council
AWS	Amazon Web Services
BAE	British Aerospace
BoM	Bureau of Meteorology (Australia)
CAL/VAL	Calibration and Validation
CEOS	Committee on Earth Observation Satellites
CEODA	Continuity of Earth Observation Data for Australia
CNES	Centre National D'Etudes Spatiales (French National Centre for Space Studies)
CRC	Cooperative Research Centre
CRC-SI	Cooperative Research Centre for Spatial Information
CRS	Commercial Remote Sensing (US)
CSDA	Commercial Smallsat Data Acquisition Program (NASA)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DESE	Department of Education, Skills, and Employment (Superseded by the Department of Education and Department of Employment and Workplace Relations)

DISR	Department of Industry, Science and Resources
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)
EARSC	European Association of Remote Sensing Companies
EEZ	Exclusive Economic Zone
EMO	Earth and Marine Observing
EO	Earth observations
EOA	Earth Observation Australia
EOS	Earth Observation from Space
EROS	Earth Resources Observation and Science
ESA	European Space Agency
EU	European Union
FTE	Full-Time Equivalent
GA	Geoscience Australia
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GTS	Global Telecommunication System (WMO)
HDR	Higher Degree Research
IaaS	Infrastructure as a Service
ISO	International Standard on Risk Management
IP	Intellectual Property
ISRO	Indian Space Research Organisation
IT	Information Technology
JAXA	Japan Aerospace Exploration Agency

JMA	Japan Meteorological Agency
LAG	Landsat Advisory Group (NGAC)
LEO	Low Earth Orbit
ML	Machine Learning
MOUs	Memorandum Of Understanding
MRFF	Medical Research Future Fund
NASA	National Aeronautics and Space Administration
NHMRC	National Health and Medical Research Council
NSMEO	National Space Mission for Earth Observation (AU)
NGAC	National Geospatial Advisory Committee (US)
NOAA	National Oceanic and Atmospheric Administration (US)
NWP	Numerical Weather Predictions
OECD	Organisation for Economic Co-operation and Development
PaaS	Platform as a Service
PSPF	Protective Security Policy Framework
RBG	Research Block Grants
RRR	Rolling Review of Requirements (WMO)
RTP	Research Training Program (AU)
SAR	Synthetic Aperture Radar
SIA	Satellite Industry Association
SIAA	Space Industry Association of Australia
SLATS	Statewide Land and Trees Survey (Queensland Government)
SNWG	Satellite Needs Working Group (NASA)
SPU	Space Policy Unit
SSTL	Surrey Satellite Technology Ltd
SWIR	Short-wave Infrared
TAFE	Technical and Further Education

TPM	Third Party Mission Program (ESA)
TSMIT	Temporary Skilled Migration Income Threshold
UN	United Nations
USGS	United States Geological Survey
VIIRS	Visible Infrared Imaging Radiometer Suite
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization

Selected CEOS Catalogue of Satellite Missions (Current and Future)

Mission Name Abbreviation	Mission Name Full	Mission Agencies	Mission Status	Launch Date	EOL Date
ALOS-2	Advanced Land Observing Satellite-2	JAXA	Operational (extended)	24-May-14	Dec-25
ALOS-4	Advanced Land Observing Satellite-4	JAXA	Approved	Mar-24	Mar-30
AOS-PMM	Atmosphere Observing System - Precipitation Measuring Mission	JAXA, CNES, NASA	Planned	2029	2034
AOS-Sky	Atmosphere Observing System - Sky	NASA, ECCC, USask, UQAM, CSA	Planned	2031	2036
AOS-Storm	Atmosphere Observing System - Storm	NASA, JAXA, CNES	Planned	2029	2031
Aqua	Aqua (formerly EOS PM-1)	NASA, JAXA, INPE	Operational (extended)	4-May-02	Sep-23
Biomass	Biomass	ESA	Approved	Mar-25	Oct-30
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations	NASA, CNES	Operational (extended)	28-Apr-06	Sep-23
CloudSat	CloudSat	NASA, DoD (US), CSA	Operational (extended)	28-Apr-06	Jan-24
EnMAP	Environmental Mapping and Analysis Program	DLR	Operational (nominal)	1-Apr-22	Sep-26
Himawari-10	Himawari-10	JMA	Approved	Mar-29	Mar-45
Himawari-8	Himawari-8	JMA	Operational (nominal)	7-Oct-14	Mar-30
Himawari-9	Himawari-9	JMA	Operational (nominal)	2-Nov-16	Mar-30
JPSS-1	Joint Polar Satellite System - 1 aka NOAA-20	NOAA, EUMETSAT, NASA	Operational (nominal)	18-Nov-17	Jun-27

Mission Name Abbreviation	Mission Name Full	Mission Agencies	Mission Status	Launch Date	EOL Date
JPSS-2	Joint Polar Satellite System - 2	NOAA, EUMETSAT, NASA	Commissioning	10-Nov-22	Nov-28
JPSS-3	Joint Polar Satellite System - 3 (Polar Follow-on	NOAA, EUMETSAT, NASA	Planned	2026	2035
JPSS-4	Joint Polar Satellite System - 4 (Polar Follow-0n	NOAA, EUMETSAT, NASA	Planned	2031	2038
Landsat 7	Landsat 7	USGS, NASA	Operational (extended)	15-Apr-99	Sep-25
Landsat 8	Landsat 8	USGS, NASA	Operational (extended)	11-Feb-13	Feb-28
Landsat 9	Landsat 9	USGS, NASA	Operational (nominal)	27-Sep-21	Sep-31
Landsat Next	Landsat Next	NASA, USGS	Planned	2030	2035
MERLIN	Methane Remote Sensing Lidar Mission	CNES, DLR	Approved	Feb-28	Feb-31
NISAR	NASA ISRO Synthetic Aperture Radar	NASA, ISRO	Approved	Feb-24	Feb-27
NOAA-18	National Oceanic and Atmospheric Administration - 18	NOAA	Operational (extended)	20-May-05	Oct-24
NOAA-19	National Oceanic and Atmospheric Administration - 19	NOAA	Operational (nominal)	4-Feb-09	Oct-24
NovaSAR-1	NovaSAR-1	UKSA, CSIRO, ISRO, DOST-ASTI, Space-Eyes	Operational (nominal)	16-Sep-18	Dec-26
Pleiades 1A	Pleiades 1A	CNES	Operational (extended)	17-Dec-11	Dec-24
Pleiades 1B	Pleiades 1B	CNES	Operational (extended)	2-Dec-12	Dec-24
Sentinel CHIME-A	Copernicus Hyperspectral Imaging Mission for the Environment	ESA, COM	Approved	Dec-29	Jun-37
Sentinel CHIME-B	Copernicus Hyperspectral Imaging Mission for the Environment	ESA, COM	Approved	Dec-31	Jun-39
Sentinel CIMR-A	Copernicus Imaging Microwave Radiometer - A	ESA, COM	Approved	Oct-29	Apr-37
Sentinel CIMR-B	Copernicus Imaging Microwave Radiometer - B	ESA, COM	Approved	Oct-31	Apr-39
Sentinel CO2M-A	Copernicus Carbon Dioxide Monitoring - A	ESA, EUMETSAT, COM	Approved	Jun-26	Dec-33

Mission Name Abbreviation	Mission Name Full	Mission Agencies	Mission Status	Launch Date	EOL Date
Sentinel CO2M-B	Copernicus Carbon Dioxide Monitoring - B	ESA, EUMETSAT, COM	Approved	Sep-26	Mar-34
Sentinel CO2M-C	Copernicus Carbon Dioxide Monitoring - C	ESA, EUMETSAT, COM	Planned	2027	2035
Sentinel CRISTAL-A	Copernicus Polar Ice and Snow Topography Altimeter - A	ESA, COM	Approved	Dec-28	Jun-36
Sentinel CRISTAL-B	Copernicus Polar Ice and Snow Topography Altimeter - B	ESA, COM	Approved	Jun-30	Dec-37
Sentinel LSTM-A	Land Surface Temperature Monitoring - A	ESA, COM	Approved	Mar-29	Sep-36
Sentinel LSTM-B	Land Surface Temperature Monitoring - B	ESA, COM	Approved	Mar-31	Sep-38
Sentinel ROSE-L A	Radar Observing System for Europe in L-band A	ESA, COM	Approved	Sep-29	Mar-37
Sentinel ROSE-L B	Radar Observing System for Europe in L-band A	ESA, COM	Approved	Sep-31	Mar-39
Sentinel-1 A	Sentinel-1 A	ESA, COM	Operational (nominal)	3-Apr-14	Apr-24
Sentinel-1 C	Sentinel-1 C	ESA, COM	Approved	Mar-24	Apr-34
Sentinel-1 D	Sentinel-1 D	ESA, COM	Approved	Jun-25	Jun-35
Sentinel-2 A	Sentinel-2 A	ESA, COM	Operational (nominal)	23-Jun-15	Jul-25
Sentinel-2 B	Sentinel-2 B	ESA, COM	Operational (nominal)	6-Mar-17	Apr-27
Sentinel-2 C	Sentinel-2 C	ESA, COM	Approved	Oct-24	Dec-34
Sentinel-2 D	Sentinel-2 D	ESA, COM	Approved	Sep-28	Sep-38
Sentinel-3 A	Sentinel-3 A	ESA, EUMETSAT, COM	Operational (nominal)	16-Feb-16	Mar-26
Sentinel-3 B	Sentinel-3 B	ESA, EUMETSAT, COM	Operational (nominal)	25-Apr-18	Aug-28
Sentinel-3 C	Sentinel-3 C	ESA, EUMETSAT, COM	Approved	Oct-25	Oct-35
Sentinel-3 D	Sentinel-3 D	ESA, EUMETSAT, COM	Approved	Dec-28	Dec-38
Sentinel-4 A	Sentinel-4 A	ESA, EUMETSAT, COM	Approved	Sep-24	Mar-33
Sentinel-4 B	Sentinel-4 B	ESA, EUMETSAT, COM	Approved	Oct-32	Apr-41
Sentinel-5 A	Sentinel-5 A	ESA, EUMETSAT, COM	Approved	Mar-25	Sep-32
Sentinel-5 B	Sentinel-5 B	ESA, EUMETSAT, COM	Approved	May-32	Nov-39
Sentinel-5 C	Sentinel-5 C	ESA, COM	Approved	May-39	Nov-46

Mission Name Abbreviation	Mission Name Full	Mission Agencies	Mission Status	Launch Date	EOL Date
Sentinel-5 precursor	Sentinel-5 precursor	ESA, COM, NSO	Operational (nominal)	13-Oct-17	Sep-27
Sentinel-6 A Michael Freilich	Sentinel-6 Michael Freilich	EUMETSAT, NASA, NOAA, COM, ESA	Operational (nominal)	21-Nov-20	Jun-26
Sentinel-6 B	Sentinel-6 B	EUMETSAT, NASA, NOAA, COM, ESA	Approved	Dec-25	May-31
Swarm	Earth's Magnetic Field and Environment Explorers	ESA, CNES, CSA	Operational (extended)	22-Nov-13	Dec-25
Terra	Terra (formerly EOS AM-1)	NASA, METI, CSA	Operational (extended)	18-Dec-99	Mar-24

Selected CEOS Catalogue of Satellite Instruments (Operational and Future)

Instrument Name Short	Instrument Name Full	Instrument Agencies	Instrument Status	Instrument Type
C-Band SAR	C-Band Synthetic Aperture Radar	ESA	Operational	Imaging microwave radars
L-Band SAR	L-Band Synthetic Aperture Radar	DLR (HRC)	Proposed	Imaging microwave radars
L-band SAR	L-band Synthetic Aperture Radar	COM	Being developed	Imaging microwave radars
L-band SAR (NISAR)	L-band Synthetic Aperture Radar (SAR) (NISAR)	NASA (ISRO)	Approved	Imaging microwave radars
MODIS	MODerate-Resolution Imaging Spectroradiometer	NASA	Operational	Imaging multi-spectral radiometers (vis/IR) and ocean colour instruments
SAR-L	L-Band Synthetic Aperture Radar	CONAE	Operational	Imaging microwave radars
VIIRS	Visible/Infrared Imager Radiometer Suite	NOAA (NASA)	Operational	Imaging multi-spectral radiometers (vis/IR) and ocean colour instruments
X-Band SAR	X-Band Synthetic Aperture Radar	DLR	Operational	Imaging microwave radars

Appendix B: Detailed Evidence

B.1. Foreign Data Policy

Australia's dependency on foreign sources of satellite EO (see Table B3), means that the supply is highly contingent on the data policies of foreign governments, space agencies, and space data providers. The following table (Table B1) summarises the status of data policies of some of the main foreign suppliers of relevance to Australia.

Data Source ***Country/Agency Examples***	**Data Policy Summary**	**Key Policy Documents and Statements**
Landsat Program *US/USGS/NASA* *e.g., Landsat-8, -9*	**Free and Open for end users** Landsat data policy ensures that all data products are available to any user at no more than the cost of fulfilling user requests. The USGS provides non-discriminatory, unrestricted access to Landsat data, in internet-accessible digital formats, selected data products generated from Landsat data and from the Landsat augmentation data. Since 2008, Landsat Level-1 data, as well as Level-2 and Level-3 science products held in the USGS archive, have been available for download at no charge from a variety of data portals.	- Landsat Data Distribution Policy[1] - USGS EROS Data Citation[2] - April 21, 2008 - Imagery for Everyone[3] - Imagery for Everyone… Timeline Set to Release Entire USGS Landsat Archive at No Charge[4] - Landsat Data Access[5]
NASA Science Missions *US/NASA* *e.g., MODIS, NISAR*	**Free and Open for end users** NASA's data policy ensures that all NASA data is available fully, openly, and without restrictions. NASA commits to the full and open sharing of Earth science data obtained from NASA Earth observing satellites, sub-orbital platforms, and field campaigns with all users as soon as these data become available.	- NASA Earth Science Data: Yours to Use, Fully and Without Restrictions[6] - Data and Information Policy[7] - Open Data, Services, and Software Policies[8]
NOAA Weather Satellites *US/NOAA*	**Free and Open for end users**	- Policy on Access and Distribution of

[1] https://www.usgs.gov/media/files/landsat-data-distribution-policy

[2] https://www.usgs.gov/centers/eros/data-citation

[3] https://www.usgs.gov/landsat-missions/april-21-2008-imagery-everyone

[4] https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/USGStechann-20080421-landsat-imagery-release.pdf

[5] https://www.usgs.gov/landsat-missions/landsat-data-access

[6] https://www.earthdata.nasa.gov/learn/articles/nasa-earth-science-data-yours-use-fully-and-without-restrictions

[7] https://www.earthdata.nasa.gov/engage/open-data-services-and-software/data-and-information-policy

[8] https://www.earthdata.nasa.gov/engage/open-data-services-and-software

Data Source *Country/Agency* *Examples*	Data Policy Summary	Key Policy Documents and Statements
e.g., VIIRS, JPSS	NOAA provides open data to support weather forecasting, climate monitoring and various scientific research. NOAA provides access to its data on a full and open basis and serves as a leading advocate for this policy internationally.	Environmental Satellite Data and Products[9] - System of Records Notices[10]
Copernicus Program *European Commission/ESA* *e.g., Sentinel-1, -2, -3, -4, -5, Future Sentinels*	**Free, Full, and Open for end users** Copernicus Program provides data and information that can be browsed/discovered without prior registration, but registration is always required for downloading. Considered as a public good, EO data delivered by the Sentinel satellites, and the data and information delivered by the 6 Copernicus services are available to users on a free, full, and open basis.	- Access to Data[11] - Data and Information Access Services[12]
ESA Science and Technology Development *Europe/ESA* *e.g., BIOMASS*	**Open Access for end users** ESA provides free and open access to data for many of its satellite missions, including the Biomass mission. There are certain datasets that may require prior approval for access due to access policy, technical and/or financial constraints. These datasets, referred to as 'restrained datasets', necessitate users to submit a data access request. Upon approval, data is provided free of charge in many cases, but there is sometimes a cost associated.	- How to access data[13] - ESA Climate Office Key Documents[14]
German Missions *Germany/DLR* *e.g., EnMAP*	**Open Data for end users** DLR provides access to EnMAP satellite data to the public, researchers, and various user communities for free or at minimal cost.	- Data Guide[15] - EnMAP Acceptable Use Policy and Conditions of Use[16]

[9] https://www.ospo.noaa.gov/Organization/Documents/PDFs/NESDIS_Data_Access_Distribution_Policy.pdf

[10] https://www.osec.doc.gov/opog/PrivacyAct/SORNs/noaa-11.html

[11] https://www.copernicus.eu/en/access-data

[12] https://www.copernicus.eu/en/access-data/dias

[13] https://www.esa.int/Applications/Observing_the_Earth/How_to_access_data

[14] https://climate.esa.int/en/projects/biomass/key-documents/

[15] https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-5368/9016_read-37549/

[16] https://www.enmap.org/data/resources/EnMAP_AUP.pdf

Data Source *Country/Agency* *Examples*	Data Policy Summary	Key Policy Documents and Statements
French Missions *France/CNES* *e.g., MicroCarb, SPOT*	**Open Data for end users** CNES provides a wide range of satellite data for free to benefit scientific research, innovation and applications development.	- Access to satellite data[17]
JAXA Missions *Japan/JAXA* *e.g., ALOS-2*	**Open and Free Data for end users** JAXA ALOS-2 data are available for public access. Anyone can use this data free of charge, subject to the terms of use for each platform. JAXA provides free spaceborne sensor data through its service platform called G-Portal.	- ALOS-2 PALSAR-2 ScanSAR Products[18] - G-Portal Terms of service[19] - Terms of Use of Research Data[20]
Japanese Weather Satellites Japan/JMA *e.g., Himawari-8, -9*	**Free and Open access to users** JMA Himawari-8 and Himawari-9 capture high-resolution imagery of the Asia-Pacific region, including weather patterns, cloud cover, and other environmental data. Use of the data provided from the system is limited to non-profit purposes such as research and education based on the policy of the JMA.	- JAXA Himawari Monitor[21] - JAXA Himawari Monitor P-Tree System[22]
Global Weather Satellites various operators e.g., SNPP, NOAA-20, NOAA-21, Metop-B, Metop-C, GCOM-W1, FY-3E, Meteosat-8, Meteosat-11, Himawari-9	**Free and Open Exchange – Public Good Principle** WMO's data policy, especially concerning satellite data, is grounded in the need for global cooperation to ensure comprehensive meteorological data coverage and its free exchange for various applications, from weather forecasting to climate research.	- WMO Unified Data Policy is a cornerstone resolution that governs the international exchange of meteorological and related data and products. - Recent updates to data policy suggest an ambition to broaden the scope of data to climate and broader areas of EO application.[23]

Table B1: Status of data policies of some of the main foreign suppliers of relevance to Australia.

There have been several examples (see below) which illustrate the kinds of unexpected changes and impact that foreign data policies can undergo, placing users that heavily depend on them in a precarious position.

[17] https://www.connectbycnes.fr/en/access-satellite-data

[18] https://www.eorc.jaxa.jp/ALOS/en/dataset/palsar2_l22_e.htm

[19] https://gportal.jaxa.jp/gpr/index/eula?lang=en

[20] https://earth.jaxa.jp/en/data/policy/index.html

[21] https://earth.jaxa.jp/en/data/2529/index.html

[22] https://www.eorc.jaxa.jp/ptree/faq.html

[23] https://public.wmo.int/en/resources/bulletin/wmo-data-policy-21st-century

JAXA/ALOS Data Node Network, 2010: As a part of preparing for the substantial increase in data volumes created by the Advanced Land Observing Satellite (ALOS, launched 2006), Japan and JAXA set about establishing a Data Node Network by engaging several international partners including the US, Europe, Thailand, and Australia (Geoscience Australia, GA). Network participants were to receive the right to utilise and distribute the data in exchange for their investment in ground station facilities. This led GA to invest in the establishment of a ground station at Alice Springs and a significant data processing and storage system – driven by the value of the data for national mapping programs. The international negotiation and development process went for many years, starting around 2001. However, in late 2010, without prior notice the Government of Japan unilaterally took the decision to alter this data policy pursuing, "industrialisation of the space program". This was implemented by allowing existing MOUs to expire in short order and led to the granting of exclusive rights to data distribution to Japanese geospatial company PASCO Corporation.

This decision completely inhibited GA's ability to distribute or utilise the data, including the delivery of several derived services (e.g., mapping, emergency flood monitoring, vegetation monitoring). The policy reversal was not undertaken by JAXA, but by a ministry of the Japanese government - despite the goodwill and collaboration of the technical agency, JAXA.

After years of advocacy, the Government of Japan reversed this decision in 2019. Since December 2022, ALOS data products are freely accessible again.

US/Landsat, 1970s - current: Landsat mission data, overseen by NASA, plays a crucial role in Australia's efforts related to environmental monitoring and disaster management. However, the period from 1984 to 1992 was marked by uncertainty, as the US not only introduced charges for Landsat data but also attempted to commercialise its distribution by transferring its management to a private company (Herron, 2022). Even though these actions were rolled back by the Land Remote Sensing Policy Act of 1992, they emphasise the vulnerability of Australia's data access to decisions made by foreign entities.

This vulnerability was underlined again in 2018 when under the Trump administration, the Landsat Advisory Group (LAG), a subcommittee of the National Geospatial Advisory Committee (NGAC), considered progress in commercial capabilities, a data buy approach, concerns about free and open data, and how to balance budget with data continuity (Popkin, 2018). The LAG report, entitled *Evaluation of a Range of Landsat Data Cost Sharing Models*, ultimately recommended, *"...that the Department of the Interior not implement any fees for Landsat data with the characteristics of Landsat 8 and 9."* (Landsat Missions, 2019). However, this does not rule out future changes. Such changes may compel Australian end users to incur millions of dollars of costs annually just to sustain their existing level of Landsat data consumption.

In the period from 1984, one of the largest Australian monitoring programs using EO imagery was the Queensland Government Statewide Land and Trees Survey (SLATS), which only acquired one Landsat scene per area on an annual basis (mostly due to cost). When Landsat imagery became free and open data in 2008, the SLATS program moved to a full time series analysis (i.e., all available images for an area) and resulted in increased accuracy in the monitoring of vegetation in Queensland.

Taking this a step further, around 381 Landsat scenes are required to cover the Australian continent (including Tasmania). Inflation has risen by 84% since 2001 to mean that the equivalent price in 2023 for a single Landsat scene would be $1,840 (InflationTool-Australian Dollar Inflation Calculator, 2023). At current prices it would cost approximately $700,000 to acquire Landsat imagery to cover all of

Australia at once, and around $7 million assuming a time series of 10 images. If an application used 10 images per year, for 30 years and was run across all of Australia, this would equate to $210 million dollars. During the commercialisation period of Landsat, licensing required each user to pay for the data i.e., not just once by the federal government. This would equate to billions of dollars and mean that many current commercial applications would not be financially viable and would not exist.

European Copernicus Missions, 2014 - current: Similarly, the European Commission's Copernicus program has also been the subject of deliberations concerning the possibility of adopting a commercial pricing model. In the position paper released by the European Association of Remote Sensing Companies (EARSC) in October 2013, titled "*View of the EO Services Industry on the Copernicus Regulation*, it was noted that, *"Industry supports the proposal that data from Copernicus satellites will be free and open to all users from nations which are* ***contributing to the programme****"* (EARSC, 2013). While ultimately the data was made free and open globally, this shows that discussion within Europe has not always been unanimously in favour of free and open data for international partners. In a more recent 2019 position paper entitled *Industry view of the future of the Copernicus programme: key issues to address*, EARSC supports, *"...Copernicus free, full and open data policy and to complementary actions that would introduce an element of reciprocity vis-à-vis third countries"* (EARSC, 2019).

These examples underscore the challenges that arise from Australia's dependence on foreign entities for data. Sudden shifts in policy can not only disrupt Australia's data access but also lead to significant budgetary implications.

In addition to significant goodwill, foreign governments and industry have invested the equivalent of billions of Australian dollars in the creation and deployment of satellite systems. This investment is ultimately underwritten by the taxpayers and shareholders in those countries and companies. By comparison, Australia has invested very little directly in its national or commercial EO satellite fleet. To provide a sense of scale, Table B2 shows the approximate EO budget and market capitalisation for some significant Australian data suppliers.

Public good	Commercial
US: ● NASA: USD 2.5 Bn (AUD 3.7 Bn) ● NOAA: USD 6.8 Bn (AUD 10.4 Bn) ● USGS: USD 1.7 Bn (AUD 2.6 Bn) Europe Copernicus space component: ● EUR 3.24 Bn (AUD 5.7 Bn) Japan: ● ALOS-3 approx. budget: 28 Bn yen (AUD 296 Mn)	● Maxar / World View (US): USD 4.00 Bn market cap ● ICEYE (Finland): USD 313 Mn startup funding ● Planet (US): USD 938 Mn market cap ● Pleiades (France): EUR 600 Mn investment by Airbus ● Black Sky (US): USD 250 Mn ● Capella (US): USD 500 Mn to $US 1 Bn valuation range ● SSTL (UK): GBP 50 Mn acquisition by Airbus (2008) ● Satellogic (US, Argentina): USD 170 Mn market cap ● CosmoSkyMed (Italy): EUR 900 Mn to build constellation
Australia: ● NovaSAR-1: AUD 10.45 Mn over seven years 2018-2025 via licence agreement with SSTL	Australia: ● LatConnect60: pre-funding startup with data supplied under licence from SSTL

Table B2: Indicative summary of approximate 2023 financial footprint for agencies and companies operating significant Australian satellite EO data supply satellite systems (data sources identified based on 2023 user survey process)

The Australian government, research sector, and national industry holds an operational stake in very few EO satellites. To our knowledge it has control over no civil domestic EO satellites (Table B2). This means that almost all the satellite EO data used by Australia is provided by foreign governments and industry. To date, this data supply has been secured on commercial terms, or via Australia's strong international relationships and goodwill, in particular with the US and Europe. Inherent in this dependency is an element of risk that geopolitical shifts or changes in policy could potentially disrupt the consistent flow of data.

Public Good	Commercial
US: ● Landsat series ● MODIS (started end of life as of mid-2023) ● VIIRS ● Meteorological supply (enabled by WMO Unified Data Policy) Europe: ● Copernicus Sentinel program (six distinct operational data streams) ● ESA Earth Explorers ● Meteorological supply (enabled by WMO Unified Data Policy) Japan: ● ALOS radar imaging ● Meteorological geostationary (enabled by WMO Unified Data Policy)	● ICEYE (Finland) ● Planet (US) ● Pleiades (France) ● Maxar / World View (US) ● Black Sky (US) ● SPOT (France) ● Capella (US) ● SSTL (UL) ● Satellogic (US, Argentina) ● Airbus (Europe) ● CosmoSkyMed (Italy)
Australia: ● NovaSAR-1*	Australia: ● LatConnect60*

*Table B3: Indicative summary of EO satellite data supply for Australian users based on the 2023 survey * NovaSAR (CSIRO) and LatConnect60 supply is secured via a commercial acquisition and supply agreement with SSTL (UK).*

B.2. Commercial Services

In many government space programs, there is a growing emphasis on commercial provision of services or public-private partnerships for complementary data to supplement or fill gaps, through mechanisms such as direct contracts (e.g., SpaceX on Artemis[24]), NASA's Commercial Smallsat Data Acquisition Program (CSDA)[25], and ESA's Third Party Mission Program (TPM)[26]. This approach reinforces government support for national industrial policy, leverages industrial capital and skills to build national capabilities, and allows for rapid progress outside of government procurement processes. This is demonstrated by the rise of SpaceX and other private sector launch companies in the US anchored by government contracts and leading to reduced costs for accessing space. However, this model provides less control over data quality, distribution, and service reliability (see evidence B.4).

[24] https://www.nasa.gov/humans-in-space/nasa-awards-spacex-second-contract-option-for-artemis-moon-landing/

[25] https://www.earthdata.nasa.gov/esds/csda

[26] https://earth.esa.int/eogateway/missions/third-party-missions

Additionally, the profit-driven nature of the private sector may undermine the supply of operational data required by the government if these data streams do not remain profitable outside of government use cases. This is a significant risk to Australia, given its reliance on data from international partners.

B.3. Acquisition or Distribution Strategy

It is common practice for many international satellite operators to only collect data over areas of interest from their national perspective, or to have a reduced collection strategy in other areas outside these areas of interest.

At the 6th AOGEO (Asia-Oceania Group on Earth Observations) Workshop held on May 2023 in Macau, China (AOGEO, 2023), China's Chang Guang Satellite Technology announced the release of "the world's first 5-metre-resolution Broadband Multi-spectral Satellite Dataset (JLS-5M)" (Xing, 2023). Notably the data is being made available through China GEOSS only to the 65 "Belt and Road" countries. Previous GEO sanctioned dataset releases have been global in nature, but this regionally selective approach reflects a potential strategy shift towards the distribution of free and open data selectively, and in the national interest. This may precipitate an eventual move away from global free and open data releases. This is important as currently Australia must rely on the goodwill of its international partners to implement an acquisition and distribution strategy that will meet its needs.

The primary aim of Copernicus services is to serve the needs of ESA/EU member states. Other EO user communities, including Australia, are served by these missions on a 'best effort' basis and with 'lower priority'. For the Sentinel-1 mission, the reduced capacity due to the loss of Sentinel-1 B from the constellation, has resulted in reduced image acquisition over Australia (ESA, 2023) due to prioritisation of captures for other areas.

A further example of how mission sovereignty affects the supply of EO data for Australia, is that due to the chosen orbital positions of geostationary infra-red sounders, no missions currently cover Australia. The US and EC agencies are the main implementing agencies for geostationary infra-red sounders which cover their regions (GOES NOAA and MTG-1 EUMETSAT respectively). This may change with JMA's Himawari-10 launch in 2028, which is planned to have an infra-red sounder.

ESA Third Party Mission data is generally not purchased over Australia, as its primary purpose is to serve European interests. This includes commercial imagery that is higher in spectral resolution such as ICEYE or Planet. Australia is responsible for purchasing its own access to imagery from these companies. Another example is that the upcoming joint NASA/ISRO dual wavelength radar mission (S-band and L-band), NISAR, will only capture S-Band imagery over areas of Indian interest (NASA, 2023). The S-Band data will be used to support studies of coastal bathymetry, ocean winds, geology, and coastal shoreline studies. It will however also be used in polar areas (which are also of interest to Australia).

A selective data distribution or acquisition strategy adopted by a state or private actor seeking to gain regional or global strategic geopolitical advantage, while seemingly generous, could threaten the commercial satellite data sector by making it challenging for providers to compete with free, high-quality data. It further amplifies the risk of global reliance on a singular foreign data source, potentially compromising data integrity and transparency, and influencing international decisions and power dynamics.

These targeted approaches to data collection and dissemination favour nations that align with specific political interests, which can serve as a tool for political leverage and diplomacy. Consequently, countries not privy to this data, like Australia, face potential regional informational disparities and are forced to navigate a landscape with geopolitical controls of satellite data access.

B.4. Data Quality

The rapid growth in popularity of 'smallsats' (< 500 kg, generally < 100 kg in mass) in recent years has led to the entry of many new data providers into the marketplace. In general, these satellites trade off data quality for higher quantity and temporal frequency; typically as a result of including lower quality components, lesser or no end-to-end calibration, and less rigorous system engineering practice. While these systems may be sufficient for some commercial applications, this lesser quality may not be sufficient for rigorous scientific or governmental applications.

This may include reduced or less well characterised radiometric calibration and reduced geometric accuracy relative to higher quality governmental systems (e.g., Landsat, Sentinel-2). Both radiometric and geometric quality impacts the applicability of these data for series analysis, including machine learning workflows which require consistently processed datasets. Characterisation and inconsistency also have significant impacts on the ability to inter-compare and interoperate data from different sensors.

B.5. Geopolitical Tensions

As countries such as China and Russia rapidly advance their space and counterspace capabilities, there is a potential strategic risk to the US and its allies, including Australia, in the Indo-Pacific region (Stokes et al., 2020). With China's space infrastructure becoming increasingly potent (Greene, 2023), coupled with their ability to potentially deny adversarial powers access to space assets, Australia's reliance on Western nations for EO data might be disrupted. In the case of China, dual-use technology development, emphasising both military and economic growth, and the broader push for space superiority presents the potential to jeopardise the consistent, unimpeded supply of EO data to Australia.

The advancements and organisational restructuring under the China's People's Liberation Army (PLA) Strategic Support Force further heighten China's rise in space operations. As the US faces challenges to its space assets and military efficacy (Tingley, 2023), Australia might find its EO data supply chain compromised due to geopolitical shifts and evolving strategic contests in space.

B.6. Government Regulation of Commercial Sector

These types of policy are implemented via control of the national government presiding over the jurisdiction where the commercial company is based. In the US context, the Commercial Remote Sensing (CRS) Policy (National Security Policy Directive, NSPD-27) covers licensing that limits the spatial resolution of imagery sold for commercial use and other restrictions broadly grouped colloquially under shutter control limitations. For example until 2020, the resolution of images sold by US commercial EO satellites was limited by regulation to 0.5 m or coarser spatial resolution (even though EO satellites were capable of imaging at finer spatial resolution). In 2020 regulations on the commercial sale of higher than 0.5 m spatial resolution satellite imagery were relaxed, largely due to

the commercial availability of higher resolution imagery from foreign countries and to allow US companies to compete internationally (NOAA, 2020), e.g., recent licence relaxation to allow Umbra to sell 16cm SAR imagery. In practice, shutter control over specific locations or periods of time, is usually implemented by government purchase of exclusive image use, rather than physically 'closing the shutter' (Satellite Industry Association, 2022).

B.7. Launch Failure or Launcher Supply Constraints

The recent failure of the H3 (Miyazawa, 2023) rocket has had significant repercussions for Japan's space program. The $208 million Advanced Land Observing Satellite-3 (ALOS-3) was lost, disrupting Japan's land observation capabilities - possibly until 2028. With the ALOS-2 satellite mission nearing completion, Japan's ability to respond to natural disasters is further weakened. This is especially concerning given Japan's susceptibility to such disasters and its role in the Sentinel Asia disaster management project. It is also notable that Japan, with mature sovereign launch capabilities, should find itself constrained in this way.

The H3 failure also jeopardises other planned missions. Japan chose to launch the ALOS-3 on the untested H3 over the tried-and-true H-2A due to budget reasons. This decision indicates that Japan prioritised other missions, such as intelligence gathering, over the ALOS-3, underscoring the government's emphasis on security and international space endeavours.

The unsuccessful maiden voyage of Japan's H3 launcher in March 2023, resulting in the loss of the ALOS-3 satellite, exemplifies the potential risks that launch failures pose to vital systems. While the rise of new commercial players and global governmental investments in launch capabilities has led to benefits like decreased launch expenses and more provider choices, incidents like the consequences of the conflict in Ukraine on launch options underlines the associated risks. The current unavailability of established launchers like Soyuz shows the challenges in accessing launch capabilities, especially for nations without independent means. Launch risks are enduring; hence, it is vital to factor in launch failure risks when planning for new or substituting satellites for Numerical Weather Predictions (NWP) data. Ensuring access to a range of launch providers is equally critical, especially if a program is suspended after a mishap or geopolitical events restrict certain launch options.

The increase in satellites being launched to orbit (and the increasing move towards satellite constellations, e.g., Starlink, Planet) has placed increased demand on launch capacity at a time when many launch vehicles are either still in development, or nearing end of life (Daehnick et al., 2023). Due to setbacks in the Ariane-6 program, Europe will not have independent space access until 2024 at the earliest. The grounding of the Vega-C rocket after its malfunction in December 2022 exacerbated Europe's limited launch options. To address this gap, the European Commission recently proposed an "*ad hoc* security agreement" to permit certain European payloads to launch via SpaceX rockets (Jones, 2023) (Foust, 2023). In the short-term, while launch services either develop or expand to full capacity, there will likely be a shortfall in supply (Daehnick et al., 2023).

The H3 setback underscores Australia's vulnerabilities when overly reliant on international allies for pivotal EO data and space resources (Miyazawa, 2023). It emphasises the need for Australia to diversify its data sources, establish backup systems, and make national investments to diminish reliance on foreign technologies. The incident also brings to the fore the changing priorities of its regional allies, over which Australia has no control. Given the intricacies of today's geopolitical landscape, Australia may find itself in a precarious position, potentially unable to autonomously access

crucial EO data for defence and civilian purposes, if it continues to exclusively lean on international collaborations and commercial satellites without a robust national space initiative.

More recently, launcher supply has become further constrained with the failure of a Rocket Lab launcher carrying a Capella satellite in September 2023 (Foust, 2023).

B.8. Global Economic Outlook

Since the 2015 previous report on EO data supply risk to Australia, the global economic outlook has changed dramatically. Ongoing global inflationary pressures mean the very real risk of a global recession. In addition, attempts to manage inflation via interest rates have led to significant currency fluctuations further reducing Australian purchasing power (Taylor, 2023).

Associated reductions in national economic and social conditions, will also force many countries, including those Australia relies on for its EO data supply, to increase scrutiny of their foreign spend. The rise of increasingly nationalistic views in the parliaments around the world may also lead to a re-prioritisation of activities. The Organisation for Economic Co-operation and Development (OECD) outlook from March 2023 notes that: “Despite recent signs of improvement, recovery over the next two years is expected to be moderate. The outlook remains fragile and downside risks predominate.” Such an uncertain fiscal environment increases uncertainty in the political and budgetary continued support from Australia’s international data supply partners.

While we are not aware of specific budgetary issues for partner countries, budgetary downturns for these partners could present a risk to Australia’s EO data supply and may also drive towards alternative financial models with cost and/or supply implications. Swift international changes have been seen in other long-standing international arrangements, including the US announcing under the Trump Administration its withdrawal from the World Health Organization and re-prioritising funding to domestic programs (Congressional Research Service, 2020) and the elimination of voluntary contributions to United Nations programs. Under global inflationary pressures ongoing programs will face national scrutiny, and participation re-evaluated (CFR, 2023). Programs may not necessarily stop, but there is a potential decrease in support for international needs.

Furthermore, fiscal uncertainty in the US can also impact key Australian data providers. During the 2013 US government shutdown (1-16 October 2013), NASA furloughed around 97% of its workforce, leading to a significant reduction in its activities. At this time, the USGS also stopped many of its operations and even took its website offline, limiting access to data and reports. NOAA continued its essential services like the National Weather Service but suspended many research activities, with a significant portion of its workforce furloughed (EarthSky, 2013).

The 2018-2019 shutdown (22 December 2018 to 25 January 2019) again saw a substantial impact on these agencies. NASA's non-critical activities were paused due to the furloughing of many employees. The USGS faced interruptions in data availability and report releases, with its online portals not being updated. NOAA's critical weather forecasting services remained uninterrupted, but many other activities, including data distribution and research, faced significant delays.

During both shutdowns, while data collection from satellites might have continued, the reduced staffing led to processing, analysis, and distribution delays, or the loss of key ancillary data streams required for analysis ready data generation. When operations resumed post-shutdown, the agencies faced backlogs, causing further delays in data availability and other services. These impacts resulted

in increased latency of data flowing into the Australian applications that the data supports. Such US government shutdowns remain a reality in 2023 and are forecast for 2024.

B.9. Congestion in Orbit

Between 1 December 2022, and 31 May 2023, SpaceX's Starlink broadband satellites executed over 25,000 collision-avoidance manoeuvres, a figure double that of the prior six months, as detailed in a report to the US Federal Communications Commission. Since Starlink's inception in 2019, these satellites have undertaken more than 50,000 such manoeuvres (Pultarova, 2023). This significant six-month growth, reflecting an exponential curve, raises pressing concerns among experts about the sustainability and safety of orbital operations, especially as thousands more satellites are set to launch in the upcoming years. This may mean that (for example) an orbit altitude of 550 km is no longer viable, or there may be very high development, management, and spacecraft costs to manage the risk of conjunction.

The increasing amount of space debris is a significant challenge for EO satellites. As the density of space debris increases, satellites are required to make frequent manoeuvres to avoid potential collisions. This results in higher operational costs or shortens operational life – as more fuel is needed to take evasive actions and an increasing requirement for ground segment resources to manage these complex space operations. Older satellites, designed when congestion was less of a concern, may lack the onboard capabilities to detect and avoid debris, making it even more challenging to keep the satellites safe and operational.

B.10. Data Provenance

The potential exists for AI algorithms to craft deep fake satellite imagery, depicting false or altered events, which, when undetected, can misguide decisions from policy to tactical levels (Erwin, 2023). This capability has been studied in a recent paper titled *Generate Your Own Scotland: Satellite Image Generation Conditioned on Maps* which showed the generation of satellite images using machine learning based only on OpenStreetMap inputs (Espinosa & Crowley, 2023).

Moreover, cybersecurity vulnerabilities could allow malicious actors to tamper with satellite data streams or storage systems, leading to data that, once analysed, yields misleading conclusions. The crux of the threat lies in the inability to trace the data's origins or confirm its authenticity, posing significant strategic and operational risks, especially when such data influences sectors like national defence, disaster response, and environmental monitoring. In this evolving landscape, safeguarding the veracity of satellite EO data through provenance verification becomes imperative for accurate and trustworthy decision-making.

B.11. Image Tasking Availability

Commercial high resolution EO satellite data collection is heavily concentrated over conflict zones, such as Ukraine, and areas requiring maritime surveillance for monitoring fishing boat and shipping movements. This often results in satellites being preoccupied, causing difficulties in tasking them for other regions, including Australia. Consequently, there are prolonged delays, and by the time the imagery becomes available, it may no longer meet the user's needs. For instance, the data might fall

outside the desired acquisition period, or it might coincide with seasons of dense cloud cover, making image acquisition either impossible or resulting in cloud-obscured images.

B.12. Duty Cycle (NovaSAR-1 Example)

The NovaSAR-1 duty cycle means that Australian acquisition requests often conflict with those of other partners such as the Philippines. As a result, CSIRO has had to compete with and in some cases lose acquisitions either *ad hoc* or systematically in cases where there are requests that go beyond satellite capabilities.

B.13. Regional Commercial Satellite EO Pricing and Access Policies

Maxar already prices products globally by region - for example, its African-registered users pay lower prices for the same products/digital goods compared with its Australian-registered users.

Furthermore, access to imagery collected over regions considered politically or otherwise sensitive to the commercial provider (and their governing country) is restricted, irrespective of whether the Australian purchaser has on-ground interest.

In addition, the cost of the same data may vary according to whether the data is archive, new archive, fresh capture, or emergency response.

B.14. Consolidation of Global Cloud Computing Providers

Three major cloud service providers account for 65% of the global cloud computing market share in the second quarter of 2023. Amazon Web Services (AWS) leads with a 32% share, followed by Azure with 22% and Google Cloud with 11%. In addition to these prominent players, there are other notable cloud computing infrastructure service providers including IBM Cloud, Salesforce, ORACLE, and Tencent Cloud each holding a portion of the market. The collective revenue generated by cloud infrastructure services during Q2 2023 amounts to USD 65 Bn. Their infrastructure includes Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) as well as hosted private cloud services (Statista, 2023).

Approximately 50% of corporate data is currently stored and administered through cloud systems. By the year 2025, it has been projected that half of the world's data, totalling approximately 100 zettabytes will have its home in the cloud (Softkit, 2023).

On-premise servers tend to incur higher costs compared to cloud computing infrastructure. The average expense for an on-premise server is within the range of $1,000 to $25,000 and depending on the robust server requirements this figure could rise. A cloud server is obtainable for around $400. Therefore, on-premises computing is 150% to 525% more expensive than cloud computing infrastructure, depending on the specific server requirement within the given cost range (Hunter, 2022). This significant cost advantage could be expected to further lock in EO applications to the cloud paradigm, and over time could be expected to create monopoly or oligopoly conditions, with the kinds of limitations, constraints, and loss of flexibility those conditions imply.

B.15. Consolidation of Earth Observation Upstream and Data Suppliers

It is probable that there will eventually be a consolidation in upstream data suppliers via acquisition and market attrition. This could have an impact on the reliability of supply for key operational programs. While at the moment the marketplace appears to be healthy, with a variety of data suppliers, the number of suppliers could reduce over time.

Several examples of consolidation have been observed:

- **Planet acquires Sinergise:** In August 2023, Planet acquired the Sinergise business including Sentinel Hub to extend its business operations in Europe and enhance the capabilities of Planet's Earth Data platform (Vitale, 2023). The consolidation of data platforms under a single entity might limit choices for EO data users. This could potentially impact innovation, collaboration, and the development of innovative approaches to data analysis and interpretation. The availability, accessibility and pricing of data could also be influenced, potentially impacting the users who rely on Sentinel Hub data for various applications.
- **Ball acquired by BAE:** In 2023, Britain's biggest weapons manufacturer BAE Systems agreed to acquire Ball Aerospace for USD 5.6 Bn. Ball Aerospace is a specialist in instruments, sensors and spacecraft technologies that serves both military and civilian purposes, including sensitive satellite technologies and weather monitoring. Its contributions range from laser communication systems connecting infantry and drones via satellite to satellite tracking systems for monitoring potential space threats. With more than 60% of Ball's employees holding US security clearances, the acquisition raises concerns about the concentration of sensitive technology and expertise within a single entity. This acquisition could have huge implications for global security dynamics and competitiveness, as the defence industry becomes increasingly attractive for mega-deals (Jasper, 2023).
- **SSTL acquired by Airbus:** In 2009 Airbus acquired majority shareholding from the University of Surrey, enabling SSTL to fulfil its growth potential as a wholly owned subsidiary (SSTL, 2023). As a part of the larger corporation, SSTL's direction and priorities are more aligned with Airbus's broader strategies and influence the types of satellite missions, data collection and services provided.

B.16. Significant Software and Service Deprecations

In December 2019, Google formally discontinued its Fusion Tables product which had a significant impact on some users of EO and geospatial data processing workflows, requiring adaptation or alteration of services. Over a decade, Fusion Tables played a vital role in simplifying data visualisation through maps, charts, and tables. This discontinuation by Google compelled users to explore suitable alternatives among Google's evolving toolkit and migrate their existing data to these new tools, requiring an adaptation of their existing workflow (Google Blog, 2018).

B.17. Satellite Data Archives Run on Sunsetted Systems

The European Space Agency has tape data archives which require significant efforts and expense to maintain due to the obsolescence of the machines to read the datasets. This includes old processing software which can only run on operating systems which are now deemed too insecure to be

connected to modern IT networks, and therefore can no longer be safely run, as well as reading and recording equipment no longer supported by the original manufacturers (e.g., Sony).

In addition, EO tape archives often go back many decades and tape systems only remain valid for approximately five years. This means there is a constant issue where all archive holders need to move data to new storage systems before the old storage systems lose support or else the data can get stranded. For example, Geoscience Australia suffered a data stranding issue on their Digital Linear Tape archive in the 2010's, the transcription project to correct this data stranding took four years to correct.

B.18. Preferred Data Providers No Longer State of the Art

NASA's plans for its next-generation climate mission, the Atmosphere Observing System (AOS), have been downgraded to rein in cost overruns. This mission, set to launch later this decade with a budget of up to USD 2Bn, will lose an advanced laser sensor and a cloud-sensing radar band due to cost constraints. Many scientists and researchers have raised concerns, as these omissions will limit AOS's ability to address critical questions about pollution's impact on clouds and how cloud changes might accelerate global warming. Several researchers have protested the decision, arguing that the cost caps were set before recent inflation and that NASA has allowed higher cost growth for other projects. AOS was designed to build on insights from previous satellites like Calipso and CloudSat, which provided valuable data on atmospheric particles and clouds but have now reached the end of their operational life. The downgrade has sparked worries that NASA may be falling behind in EO compared to other space agencies' more advanced technology proposals (Science, 2023).

B.19. Dynamic Nature of the Earth Observation Sector

Worldwide, the EO market is evolving and growing rapidly, in each of its three major parts – acquisition, dissemination, and intelligence.

Growth in acquisition is a function of three factors:

- Advancements in the space industry leading to easier access to space and increased miniaturisation of satellite systems and subsystems
- Innovative business models allowing more customers to invest
- A combination of climate change, ecological crises, and evolving geopolitics leading to a demand for greater data volume and diversity

Growth in dissemination results from improvements in:

- Accessibility
- Interoperability
- The ability to combine or fuse data
- Usability

Intelligence can be categorised as analytics, insights, and applications, however the separation of these categories is blurring as more and more organisations enter or expand in the market. Within this part of the EO market, organisations are building custom applications, repeatable and scalable models, integrations into large software enterprises, and strategic partnerships with large consulting companies. There are also many organisations that don't sit in the EO industry but who use and apply EO intelligence in their field (Aravind, 2021; Aravind, 2022).

B.20. Monopoly Concerns in the Space Industry

One of the main concerns within the space industry revolves around the potential emergence of dominant launch providers that could have a monopolistic control over the launch of satellites (Foust, 2023). This issue was also raised by industry experts at the World Satellite Business Week conference held in September 2023 - noting that having a dominant launch provider like SpaceX might not be healthy in general for the commercial prospects of the industry. This sentiment reflects a broader concern about how such monopolistic control could impact the industry's value chain (CNBC, 2023).

B.21. Solar Activity

Solar flares have impacted spacecraft performance in the past. The sun's solar cycle of activity is an 11-year cycle that reached a low point in 2020 but is expected to peak in 2026. During these periods of higher solar activity, the frequency and severity of geomagnetic and radiation storms increase. This can lead to communication disruptions and more frequent damage to satellite systems. Such events can also affect satellite orbits, necessitating extra fuel for adjustments and reducing their operational lifespan (NOAA, n.d.).

During late 2021, when the new solar cycle started, the team managing the European Space Agency's Swarm constellation noticed a change in trend in orbit maintenance. The satellites, positioned 400 km above Earth and tasked with measuring Earth's magnetic field, were descending toward the atmosphere much faster than usual - in fact, up to 10 times the typical speed. This could indicate the beginning of a period of reduced lifespan or increased fuel requirements for satellites orbiting Earth (NOAA, n.d.).

While solar flares with high impact on Earth and Earth orbit are not common, they can have significant impact on a spacecraft and are likely to occur with little or no warning. The nature of solar flares means their potential impacts are widespread, with the possibility to impact the entire fleet of Earth orbiting satellites in extreme cases. This would include EO satellites, as well as all other satellites (e.g., GPS/GNSS, communications, human spaceflight).

B.22. Cyber Attacks

A cyberattack by Russia disabled satellite communications in Ukraine shortly before the country's invasion by Russian Armed Forces in late February 2022. This attack specifically targeted ViaSat's KA-SAT system, a provider of high-speed satellite communications to Ukraine, causing a widespread internet outage for the Ukrainians. The consequence of this attack extended beyond Ukraine, impacting the ability of the European Union to maintain satellite communications. Such cyberattacks on satellite communications, as demonstrated in the context of the Ukraine crisis, underscores the vulnerability of vital EO systems to similar attacks. The disruption of satellite systems due to cyberattacks poses a significant risk to Australia's ability to gather critical data from space-based assets. As such, it emphasises the pressing need for enhanced cybersecurity measures to safeguard these essential data acquisition systems (GMF, n.d.).

B.23. Lack of National Capability

Multiple national reviews across EO application communities (Australian Earth Observation Community Plan 2026), geospatial sector (Space and Spatial 2030 Industry Growth Roadmap), and Space Sciences (Australian Academy of Science – Australia in Space: a decadal plan for Australian space science 2021–2030) have identified an ongoing EO satellite program as a national priority, and the National Space Mission for Earth Observation (NSMEO) with its focus on EO and climate science held significant potential to benefit numerous Australian government, research and industry sectors. The cancellation of NSMEO raises questions about Australia's ability to secure critical EO data crucial for understanding climate change impacts, natural disaster management, weather forecasting, water resource monitoring, etc (Australian Academy of Science, 2023).

Australia's lack of a national space program leaves it dependent on a limited set of foreign government and industry providers, posing domestic risk (Shrimpton, 2023). This may also deter global partners from collaborating with the Australian space industry (SIAA, 2023). The NSMEO's cancellation emphasises the need for a national plan to ensure Australia's competitiveness in the global space sector (Spatial Source, 2023).

B.24. Missions Reach End of Life Without Equivalent Replacement

This is exemplified recently by resourcing for the critical MODIS instrument on NASA's Terra and Aqua missions, where resourcing has been drastically reduced and the mission is reaching end of life. A recent change in the Terra mission is prompting the flight operation staffing to go from 24 hours a day to 12 hours a day, 7 days a week (https://terra.nasa.gov/).

MODIS is currently used operationally to map fire hotspots and fire scars in Australia - a service that has not identified a replacement source of EO data. This service is used by fire management authorities as part of the response and planning strategy (NAFI, firenorth.org.au). In the results from the survey completed as part of this study (i.e., this report) 62 survey respondents said they regularly use MODIS data (45% of EO data respondents) and MODIS data was reported as the fourth most used satellite data amongst the survey respondents.

While several similar missions or instruments exist (e.g., Sentinel-3/ESA/EUMETSAT, VIIRS/NOAA), none are found to be a complete replacement for the MODIS mission, and this gap will impact the delivery of many services, such as NAFI (described above).

B.25. Australian Needs, Interests, and Conditions not Serviced by Future Missions

Several government programs have been developed based on long-term, historical satellite EO data. Future extensions and/or improvements to these programs may be limited if design plans for new sensors in continuing or replacement missions do not include or are not relevant to Australian conditions or projects.

Australia is not able to directly contribute to the EO mission advisory boards of ESA, NASA and others to determine the mission requirements that become operational, or the science questions to be investigated.

For example, Australia's specific needs in regard to water quality monitoring are not met by international partner missions, which do not have the optimal spatial and spectral resolution for

monitoring Australia's typically small and/or narrow inland water bodies. There is currently no international mission under development that will meet all of the needs identified in Australia for monitoring water quality.

There are many other areas where Australia has specific needs that aren't met by international partner EO missions. These include active fire monitoring, sea ice monitoring, search and rescue needs in the Australian maritime search and rescue region, amongst others. Crop monitoring of horticultural crops or tree crops for agricultural statistics requires finer resolution imagery to differentiate crops in smaller plots than existing medium resolution open-source data will allow (Australian Bureau of Statistics, 2022). In addition, if SWIR bands are not included in future missions, advances in technology and methodology using this wavelength for mining, agricultural and other applications cannot progress.

B.26. Variations in Processing Levels Between Imagery Providers and Over Time

Technology and methodology improvements over time and/or methodology "preferences" can result in inconsistencies between "equivalent" processing levels from different providers, between missions or processing versions from the same imagery provider, or between organisations and government agencies.

For example, ESA's processing of Sentinel-2 Level 2A went through 13 versions from 2018 to 2022 (The European Space Agency, n.d.). An additional example would be changes in the processing methodology of the (Queensland) Statewide Landcover and Trees Study (Queensland Government, 2021).

B.27. Upkeep and Maintenance of Direct Download Facilities

Although an increasing number of satellites are downlinked to the satellite operator's country and transmitted through the internet, ground stations are still a critical component in Australia's EO infrastructure. As well as receiving direct broadcast satellite missions for Australian users, ground stations can provide a powerful contribution to international satellite operators in gaining access to, and influence on missions.

The Australian National Ground Segment Technical Team (ANGSTT) establishes, operates and enhances a national EOS ground network to provide access to satellite EO data from a wide variety of government and potentially non-government sources.

ANGSTT comprises Geoscience Australia, representing the land imaging user and high-resolution low latency user communities, the Bureau of Meteorology representing the meteorological user community, Landgate representing the emergency management user community, and CSIRO representing the research user community (ANGSTT, 2023).

Direct download facilities are necessary for low-latency delivery of critical data such as MODIS for fire hot-spot mapping and to allow continued delivery of EO data during a break in the internet-based supply chain.

B.28. Low Investment in Australian Research and Development

Funding for Australian research and development is provided by a variety of sources including the Australian Government, the higher education sector, state and territory governments, industry and

the private non-profit sector. In 2022 Research and development expenditure from all sources – business, government, higher education and the private non-profit sector – fell to 1.68% of gross domestic product, representing a slump to its lowest level in at least 17 years (Ross, 2023). In 2019-20, Australia's gross expenditure on research and development was 1.79% of gross domestic product, lagging behind our competitors and well below the Organisation for Economic Co-operation and Development (OECD) 2020 average of 2.68% (Universities Funding, 2023).

In 2021-22, the Commonwealth invested AUD 11.8 billion in innovation and research - a decrease of AUD 184.18 million (or 1.53 per cent) compared to 2020-21. 31.5% of the total investment was allocated to the higher education sector through the Research Block Grant funding and the National Competitive Research. National competitive research grants are underpinned by peer-review and are run principally through the Australian Research Council and the National Health and Medical Research Council.

B.29. Skilled Workforce Shortage

Skilled workforce shortages in the Australian spatial industries have existed for over a decade (Bakalich, 2022).

By 2025, it is anticipated that there will be a shortfall in Australia of 300 geospatial specialists with tertiary qualifications. At the same time over 20% of the current workforce are likely to retire from the industry (Spatial and Surveying Diversity Leadership Network, 2018).

In addition, the rate of change in skills is accelerating. Skills are being refocused on disciplines such as data science and analytics, computer science, and data visualisation. The ongoing automation of collection processes, basic data interpretation and elements of AI are in many ways replacing human repetitive tasks, resulting in greater emphasis on training, reskilling, and upskilling for higher-value tasks in the use, creation, and maintenance of spatial information and related services (UN-GGIM, 2020).

In some Australian government departments, data volumes are greater than they are able to process with their existing workforce, while others have insufficient EO staff to accommodate requests from departments that they service.

B.30. World Meteorological Organization (WMO)

WMO is a specialised agency of the United Nations, dedicated to international cooperation and coordination on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources.

WMO facilitates and coordinates an Earth system approach to the gathering and free exchange of observations, promotion and integration of research and the development and delivery of services in the areas of weather, climate and water. The activities of WMO facilitate the maintenance and expansion of its members' atmospheric, oceanographic and land-based observational networks; the free unrestricted exchange of the resulting data and information; and related capacity development and research, in order to optimise the production of weather, climate and water-related services worldwide (WMO, 2022).

The Global Telecommunication System (GTS), a WMO program, is the communications and data management component that allows the World Weather Watch to collect and distribute information critical to its processes. It is implemented and operated by National Meteorological and Hydrological Services of Members and by international organisations and provides support to other programmes, facilitating the flow of data and processed products to meet the requirements of members in a timely, reliable and cost-effective way, ensuring that all have full access to meteorological and related data, forecasts and alerts. This secured communication network enables real-time exchange of information, critical for forecasting and warnings of hydrometeorological hazards in accordance with approved procedures (WMO, 2022).

B.31. Advanced Images: Satellite Image Generation Conditioned on Maps

The integration of advanced image generation with cartographic data as mentioned in the paper "*Generate Your Own Scotland: Satellite Image Generation Conditioned on Maps*" (Espinosa and Crowley, 2023) presents an innovative development in EO. This technology highlights the potential for state-of-the-art pre-trained diffusion models to produce realistic satellite images when conditioned on cartographic data such as OpenStreetMap vector information. While this modern technology offers promising applications, it introduces risks associated with potential misuse of synthetically generated imagery, including implications for remote sensing and geospatial analysis.

B.32. Funding Sources for University Research

Australian universities fund research activities from:

- Performance-based research block grants (RBGs) administered by the Department of Education, Skills and Employment (DESE)
- Australian nationally competitive grants such as the National Health and Medical Research Council (NHMRC), the Australian Research Council (ARC), and the Medical Research Future Fund (MRFF)
- Australian Government funding to support industry engagement
- Australian Government research infrastructure funding programs
- Other public sector research funding not awarded on a nationally competitive basis
- Student fees
- Income from research commissioned by industry and private not-for-profit organisations
- Other sources such as philanthropic donations, endowments, and crowdfunding

In 2018, the most recent figures available from the Australian Bureau of Statistics, this funding was sourced from:

- General university funds AUD 6,822.6 million (56.1%)
- Australian competitive funds AUD 1,774.1 million (14.6%)
- Other Commonwealth government AUD 1,891.2 million (15.6%)
- State and local government AUD 457.0 million (3.8%)
- Business AUD 521.9 million (4.3%)
- Donations, bequests and foundations AUD 300.5 million (2.5%)

- Other Australian AUD 0.1 million (<1%)
- Overseas AUD 390.4 million (3.2%)

(Parliament of Australia, 2022)

B.33. India's Evolving Space Policy Landscape as it Concerns the Commercial Sector and Data Supply

The Indian Space Policy of 2023, with its emphasis on encouraging participation from the Non-Governmental Entities (NGEs), raises concerns about the potential impact on the EO community. The policy allows NGEs to independently procure space technology and services from any source globally (ISRO, 2023). The increased competition and freedom for Indian NGEs to engage in various space related activities including disseminating satellite based remote sensing data, may alter the dynamics of collaborations and partnerships in the international EO market and might impact the traditional data supply chains.

Appendix C: List of Commonwealth, and State and Territory Agency Programs Using EO Data

Below is a list of Commonwealth, and State and Territory Agencies dependent programs compiled from a detailed desktop study, review of similar studies for confirmation of continuation or closure, consultation with relevant persons, and direct population of the table from some agencies.

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
1	Federal	DAFF	ABARES	Australia's State of the Forests Report 2018	**Use of Earth observation for forest management, conservation and capturing change.** The purpose of the report is to keep the public informed about Australia's forests, their management, use and conservation, and to provide information on how they are changing. It is also used to report on the state of Australia's forests to the world.	Less than $1,000,000	Medium
2	Federal	DAFF	ABARES	Catchment scale land use of Australia	**This dataset is the national compilation of catchment scale land use data for Australia (CLUM)**, as at December 2020. It replaces the Catchment Scale Land Use of Australia – Update December 2018. It is a seamless raster dataset that combines land use data for all state and territory jurisdictions, compiled at a resolution of 50 metres by 50 metres. It has been compiled from vector land use datasets collected as part of state and territory mapping programs through the Australian Collaborative Land Use and Management Program (ACLUMP).	$100,000,000 - $1 billion	High
3	Federal	DAFF	ABARES	National Forest Inventory of Australia	**Satellite derived products are used to report Australia's forest cover.** The National Forest Inventory (NFI) was established in 1988 by an Australian Government Cabinet decision, as an entity that enabled the calculation of nationally consistent and comprehensive attributes describing Australia's forests. In 1992, the role of the NFI was endorsed in Australia's National Forest Policy Statement, which was signed by all state and territory governments and the Australian Government.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
4	Federal	DAFF	ABS, GA	DEA Landcover	**Digital Earth Australia (DEA) Land Cover translates over 30 years of satellite imagery into evidence of how Australia's land, vegetation and waterbodies have changed over time.** This arose from a pilot project with ABS to develop agricultural crop maps and statistics using satellite data. ABS is working to modernise the way we produce agriculture statistics to quickly deliver information at regional scales and enable a holistic understanding of agriculture together with the environment and regional communities.	$10,000,000 - $100,000,000	High
5	Federal	DAFF	AMSA	National Plan for Maritime Environmental Emergencies	**Remote sensing can be used for detecting, tracking, assessing the environmental impact of environmental emergencies.** The National Plan sets out national arrangements, policies and principles for responding to maritime emergencies. This is how federal, state and territory response capabilities work together. EO has been used to detect an oil spill in the Timor Sea in 2010, LiDAR to assess the environmental impact of an oil spill in the GBR 2016, and satellite imagery to monitor the effectiveness of an oil spill in the Torres Strait in 2018.	$10,000,000 - $100,000,000	Medium
6	Federal	DAFF	AMSA, AIMS	Coral Spawn slicks on the GBR	**Marine safety technology tracking spawning coral slicks.** In November 2018, AMSA worked with oceanographers from the Australian Institute of Marine Science (AIMS) to track coral spawn slicks on the Great Barrier Reef which were riding the East Australian Current.	Less than $1,000,000	Low

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
7	Federal	DAFF	DAFF	National Soil Action Plan and National Soil Resources Information System/ Pilot Monitoring Incentives program for the National Soil Strategy	**The National Soil Strategy, released in May 2021 is Australia's first national policy on soil. It sets out how Australia will value, manage and improve its soil for the next 20 years.** The Strategy prioritises soil health, empowers soil innovation and stewards, and strengthens soil knowledge and capability. This is part of a broader National Soil Package and supports other programs including: Agriculture Stewardship Program, Future Drought Fund, Australian Collaborative Land Use Mapping Program, Threatened Species Strategy. Remote sensing data from satellites and aircraft is used for measuring soil properties such as soil moisture, vegetation cover and land use. In situ data is used to validate remotely sensed data and provide more information on soil properties.	$10,000,000 - $100,000,000	Medium
8	Federal	DAFF	GRDC, USYD, CSIRO, USQ, ANU, Bureau of Meteorology	Soil water nowcasting for the grains industry	**Soil Water Now - useful tools for measuring soil water.** Advances in Earth observation and computational power have made it feasible to provide estimates of soil water across large regions at the within-paddock spatial resolution for any dryland farm in Australia. Evapotranspiration (ET) from MODIS, 8-day 500m cumulative evapotranspiration is used in data	Less than $1,000,000	High
9	Federal	DAFF	BRS, CLWRA, MDBA, DCCEEW, DSEWPaC, NT DPIR, QLD DNRME, SA DEW, VIC DAFF, TAS DPIPWE	Australian Collaborative Land Use Mapping Program (ACLUMP)	**ACLUMP promotes the development of nationally consistent land-use through land use mapping coverage for Australia at both continental and catchment scale, and by developing a national information system for land management practices.** ACLUMP also facilitates national technical standards, including the Australian Land Use and Management (ALUM) Classification; a national land use data directory and the maintenance of land use datasets on Australian and State government data repositories; and regional and national reporting of land use and land management practices.	$1,000,000 - $10,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
10	Federal	DCCEEW	AAD	Annual Australian Antarctic Division - expedition preparation	**Use of high resolution imagery to conduct geological assessments in Antarctica.** Expedition staff and associated scientists from the Australian Centre for Excellence in Antarctic Science (ACEAS) and Safeguarding Antarctica's Environmental Future (SRI SAEF) will use high resolution 8 band imagery, to optimise fieldwork and research resources to achieve maximum outputs and leverage greater outcomes. $30K budget across multiple organisations (shared costs)	Less than $1,000,000	High
11	Federal	DCCEEW	ABS, CSIRO, DAFF, GA, Bureau of Meteorology, PM&C	Environmental-Economic Accounting (EEA) and Environmental Indicator Program	**Producing land, marine and terrestrial ecosystem accounts at a national scale.** Account tables are produced which include statistics reporting on national land cover, land use, land tenure; ecosystem extents (terrestrial, freshwater, coastal, estuarine and marine), ecosystem condition, and ecosystem services. Optimally, accounts will be produced annually. A current project uses Landsat 8 and Sentinel-2 data to model the distribution of mangroves, intertidal seagrass, saltmarsh, and mudflats nationally, with the capacity to include additional marine and coastal ecosystems in the future.	$1,000,000 - $10,000,000	High
12	Federal	DCCEEW	ABS, CSIRO, DAFF, GA, Bureau of Meteorology, PM&C	State of the Environment Program	**Using EO satellites to monitor and manage Country and sea Country.** Enablers of caring for Country provides a comprehensive range of solutions to support effective caring for Country emerged across the consultations with Indigenous stakeholders. Technologies and digital innovations such as artificial intelligence, drones, EO satellites are increasingly being used to monitor and manage Country, including sea Country. SoE will use EEA for trend analysis (current EPBC Act requirement, legislative reforms)	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
13	Federal	DCCEEW	AIMS	AIMS remote sensing data	**Satellite imagery is used to produce sea surface temperature of the Great Barrier Reef (GBR).** The sea surface temperature, chlorophyll-a and diffuse attenuation (ocean turbidity), and ocean colour data for the GBR are used to provide daily information about ocean surface temperatures, surface waters and the processes that drive these.	Less than $1,000,000	High
14	Federal	DCCEEW	AIMS	Aerial surveys of coral bleaching in GBR	**Using aerial surveys to determine coral bleaching extent and severity** Since 1998 aerial surveys record the percentage of visible coral cover that are bleached or not bleached. They also use eReefs and ReefTemp Next Generation to monitor reef health	Less than $1,000,000	High
15	Federal	DCCEEW	Bureau of Meteorology	Nowcasting Aviation	**Real-time weather information is used to provide important situational awareness for aviation.** The Nowcast Application server processes data from a number of radars in the network, as well as satellite data, to identify and track storm cells. BOM offers nowcast services for aviation, which provide real-time weather information, including thunderstorm activity, turbulence, icing, visibility, and wind shear. These nowcasts are essential for flight planning and in-flight decision-making.	Less than $1,000,000	High
16	Federal	DCCEEW	Bureau of Meteorology	Australian Space Weather Forecasting Centre	**The Australian Space Weather Forecasting Centre (ASWFC) delivers 24/7 space weather forecasting and warning services to Australia.** ASWFC is the public face of the Space Weather Capability (SWC) section of the Bureau of Meteorology, and provides information to Australia's space industry to understand, prepare for and respond to space weather events.	Less than $1,000,000	High
17	Federal	DCCEEW	Bureau of Meteorology	Antarctic and Southern Ocean Sea-Ice	**The Antarctic and Southern Ocean sea ice program provides maps, images, and data**. The BOM uses Earth observation data from a variety of sources, including satellites, aircraft, and ships, to monitor sea ice conditions in the Antarctic. This data is used to track changes in sea ice extent and thickness, which can provide insights into the effects of climate change, and provides a service to ships navigating close to Antarctica.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
18	Federal	DCCEEW	Bureau of Meteorology	Research, calibration /validation	**Calibration and validation for reliability of meteorological measurements.** The Bureau of Meteorology Calibration Research and Validation Project is a vital use case where satellite data is used to validate seasonal forecasts, and improve the accuracy and reliability of meteorological measurements.	Less than $1,000,000	High
19	Federal	DCCEEW	Bureau of Meteorology	Land Modelling	**Land surface products to improve process representation in hydrological models and prediction capability to increase spatial and temporal resolution**. This helps in making accurate estimates of water and vegetation dynamics for water resources management and on-ground decision making.	Less than $1,000,000	High
20	Federal	DCCEEW	Bureau of Meteorology	Solar Monitoring	**EO data is used to provide real-time, high-resolution solar radiation information.** The Bureau of Meteorology currently runs a model which produces estimates of the total amount of solar radiation that reaches the earth's surface every 10 minutes. The data is used to improve operational efficiency for solar energy providers, enhanced grid stability by allowing energy grid operators to anticipate and respond to fluctuations in solar power generation. Risk mitigation for energy producers and financiers by providing data to assess the impact of solar variability on energy assets. Increased financial optimisation for energy traders through better forecasting of supply and demand, leading to opportunities for energy arbitrage.	Less than $1,000,000	High
21	Federal	DCCEEW	Bureau of Meteorology	ACCESS Numerical Weather Prediction Models	**Weather forecasts using high resolution EO data.** The Australian Community Climate and Earth-System Simulator (ACCESS) weather models have been developed and tested by research staff from the Bureau of Meteorology's Research and Development Branch and are based on the UK Meteorological Officer's United Model. The model assimilates data from over 30 Earth observation instruments. Improvements in weather forecast quality are being achieved through improved forecasting models, advanced data assimilation techniques and incorporating new satellite technology.	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
22	Federal	DCCEEW	Bureau of Meteorology	Severe weather warnings	**Monitoring and modelling severe weather events using satellite imagery.** Severe weather events that are of concern to the public, industry, and airline industry in Australian air space include cyclones, severe storms, ice conditions and volcanic ash events. Data from weather satellites underpin monitoring and modelling of such weather events as well as the day-to-day observations that contribute to meteorological warnings. The BOM relies on data from Himawari, the low Earth orbiter A-train, the NOAA and European Metop satellites for incidents of low cloud and fog both around airports and en route. Information on cloud formations, turbulence and potential icing conditions are also important information for aircraft en route.	Less than $1,000,000	High
23	Federal	DCCEEW	Bureau of Meteorology	Fires, Australian Smoke Dispersal Service, Australian Fire Danger Rating System	**EO is used for fire weather services.** The Bureau of Meteorology provides a multitude of fire weather services, including fire danger ratings, when forecast conditions are likely to be dangerous, in consultation with fire agencies, fire danger products, such as detailed forecasts and outlooks for fire agencies and other organisations, as well as smoke forecasts to enable better health warnings.	Less than $1,000,000	High
24	Federal	DCCEEW	Bureau of Meteorology	Australian Volcanic Ash Advisory Centre (VAAC)	**The Australian Volcanic Ash Advisory Centre (VAAC) uses satellite information**, ground reports from vulcanological agencies, pilot reports, meteorological knowledge and numerical models to track and forecast ash movements to inform the public and ensure aircraft can safely fly around the airborne ash.	Less than $1,000,000	High
25	Federal	DCCEEW	Australian Antarctic Division	Australian Antarctic Division - Ice mapping	**Satellite imagery to detect icebergs and their movement** The Australian Antarctic Division is using Earth observation technologies such as satellite imagery and synthetic aperture radar (SAR) to detect and track icebergs and map sea ice.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
26	Federal	DCCEEW	Bureau of Meteorology, CSIRO, AIMS	eReefs	**eReefs uses the latest technologies to collate data, modelling and produces power visualisation, communication and reporting tools** eReefs commenced in January 2012, is a six-year $30 million collaborative project that combines government commitment to Reef protection, world-class science innovation and contributions from leading Australian businesses. Focused on the protection and preservation of the iconic Great Barrier Reef, it forms the first step in building comprehensive coastal information systems for Australia. Also related is ReefTemp Next Generation (pre-2012) (http://www.bom.gov.au/environment/activities/reeftemp/reeftemp.shtml)	$10,000,000 - $100,000,000	High
27	Federal	DCCEEW	CER	Carbon Abatement Integrity Committee	**EO could be used to track changes in land cover or vegetation and assess impact.** The committee is an independent statutory committee established under the Carbon Credits Act 2011. The committee assesses the compliance of methodology determinations (methods) against the Offsets Integrity Standards to ensure the continued integrity of the Emissions Reduction Fund.	$10,000,000 - $100,000,000	Low
28	Federal	DCCEEW	CSIRO	Habitat Condition Assessment System (HCAS)	**Use of remote sensing, spatial ecological modelling and sparse data from ground condition assessments to generate a national view of condition.** The Habitat Condition Assessment System (HCAS) for Australia provided Australia with its first consistent, repeatable and cost-efficient national biodiversity habitat condition assessment and reporting capability.	Less than $1,000,000	High
29	Federal	DISR	GA	Australian Antarctic Division mapping program - coastline change	**Using earth observation to map and monitor change in Antarctica.** Small and medium scale topographical mapping, mapping the changing coastline including ice shelves, glacier tongues and ice shelves, digitising Antarctica's coastlines, mosaics for Heard and McDonald Islands – monitoring coastline changes/digitising, observing glacial retreat/advance, mapping glacier retreat	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
30	Federal	DCCEEW	GBRMPA	GBRMP Sentinel Map Data via the GeoSpatial Hub	**Satellite data (Sub-surface reflectance - SSR) is used to monitor benthic cover types and geomorphic zonation across the Great Barrier Reef Marine Park.** The Great Barrier Reef Marine Park Authority uses GeoSpatial Hub for applications with Sentinel Map Data. Great Barrier Reef 10m Grid (GBR10) Sub-Surface Reflectance (SSR) GBRMP Map Sentinel.	$10,000,000 - $100,000,000	Medium
31	Federal	DCCEEW	JCU, GBRMPA, QPWS, QM, UQ, AAD, AIMS	Coral Sea Island Health Program	**Monitoring of Coral Sea islands and coastlines, sea grass and vegetation and feature mapping, monitor and detect changes of reefs and islands, i**mpact of rising sea levels on islands and reefs, ability to access imagery in case of natural disasters (storm damage assessment).	Less than $1,000,000	High
32	Federal	DCCEEW	MDBA	Murray-Darling Basin Monitoring	**The Murray Darling Basin Authority collects, uses and publishes satellite images of the Basin landscape**. Satellite data is usually obtained from publicly available sources including GA, USGS and USGS. We monitor how river flows behave, how water spreads across floodplains and how the land or vegetation response over time. This is carried out using near-real time data collected from Earth observation satellites for local conditions since 1987, across the Basin's 1 million square kilometre footprint.	$100,000,000 - $1 billion	Medium
33	Federal	DCCEEW	MDBA	Murray Darling Basin Authority compliance and science	**Satellite imagery plays an important role when supporting compliance activities**, providing a snapshot of the broad landscape, by providing consistent information across the Murray Darling Basin (MDB).	$100,000,000 - $1 billion	Medium
34	Federal	DCCEEW	Parks Australia	National Environmental Science Program (NESP)	**Satellite data used for monitoring reef water quality**. Funds projects that use earth observation data to study environmental challenges, such as marine biodiversity, ecosystem dynamics, and climate change impacts. The program helps indigenous communities build resilience. Satellite images of reef water colour are used on the Marine Water Quality Dashboard.	$100,000,000 - $1 billion	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
35	Federal	DCCEEW	QLD DES, GA	National Vegetation Monitoring System Environment Information Australia	**Using Landsat imagery to identify land clearing activity.** To build a National Vegetation Monitoring System to identify anthropogenic vegetation clearing activity to support the monitoring purposes of the Compliance and Enforcement Branch under the EPBC Act legislation. In the first instance Landsat imagery is required to run such algorithms on a national scale. Landsat imagery is also more accurate under consideration of cloud cover, cloud shadow and water masking. Sentinel-2, SAR and Commercial imagery may be used in the manual assessment process to confirm the identified vegetation changes.	$10,000,000 - $100,000,000	High
36	Federal	DCCEEW	States and Territories	Environment Information Australia - National Vegetation Information System (NVIS)	**EO is used to support the development, classification, and determination of vegetation on a national scale** for National Vegetation Information System (NVIS) to support trials to use a range of validation. Combining satellite information may be able to support the NVIS vegetation hierarchy.	Less than $1,000,000	Medium
37	Federal	DCCEEW	DCCEEW	Nature Positive Plan: better for environment, better for business	**Remote imaging through satellite and drone technology combined with advances in machine learning algorithms can help us monitor our environment.** Developed in response to the independent review undertaken by the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The review concluded that the EPBC Act, Australia's central piece of national environmental law, is outdated, ineffective, and requires fundamental reform. Remote imaging through satellite and drone technology combined with advances in machine learning algorithms can help us monitor our environment.	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
38	Federal	DCCEEW	DCCEEW	National Climate Adaptation and Risk Program	**EO can be used to track changes in the climate, such as rising sea levels, increasing temperatures, and more extreme weather events.** The Government is developing Australia's first National Climate Risk Assessment and a National Adaptation Plan, to better understand the risks and impacts to Australia from climate change and to invest in a plan to adapt to those risks. It will deliver a shared national framework to inform Australia's national priorities for climate adaptation and resilience actions and enable consistent monitoring of climate risk across all Australian jurisdictions.	$10,000,000 - $100,000,000	Medium
39	Federal	DCCEEW		National Water Grid Authority	**Satellite imagery can be used to map water resources and assess the impact of climate change.** The National Water Grid Fund (NWGF) is the Australian Government's infrastructure investment program to improve water access and security by delivering nationally important water infrastructure projects that unlock potential, build resilience, and promote growth and sustainability. This includes investment in essential town water, dams, weirs, pipelines, water recycling and treatment plants and other water storage, distribution and scientific solutions.	$10,000,000 - $100,000,000	Low
40	Federal	DCCEEW		Inspector General of Water Compliance (MDB)	**Satellite imagery plays an important role in supporting compliance activities** providing a snapshot of the broad landscape, by providing consistent information across the Murray Darling Basin.	$10,000,000 - $100,000,000	Medium
41	Federal	DCCEEW		Protecting the Great Barrier Reef	**Imagery is used to assess vegetation coverage, water quality, sediment erosion, wetland extent and health.** The Reef 2050 Long Term Sustainability Plan guides our actions to restore and protect the Great Barrier Reef. It is Australia's plan to improve the Reef's health and resilience.	Greater than $1 billion	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
42	Federal	DCCEEW	DCCEEW	National Inventory Systems and International Reporting (Emissions Reductions)	**Landsat and Sentinel data to report spatially accurate land use change impacts on Australia's carbon emissions agreement to the Paris Agreement** Vegetation classification, vegetation change detection, vegetation height classification, identifying human induced change activities (expansion of mining\settlements), monitor carbon and methane emissions, detecting and monitoring reservoir levels (heights), climate data, providing input into Forest Productivity Indexes.	Less than $1,000,000	High
43	Federal	DCCEEW		Marine and Island Parks Australia	**Satellite imagery is used to map and monitor changes in reef and intertidal areas**. Our Marine teams have a range of projects now and into the future that rely on satellite and aerial imagery. Map and monitor change in coral cays, intertidal areas, and oceanic reefs in Australian Marine Parks (esp. in the Coral Sea, North, and North-west regions) relies heavily on remote sensing. Satellite derived imagery is used, as well as subsurface reflectance, seafloor habitat, environmental emergencies, and illegal fishing.	Less than $1,000,000	High
44	Federal	DCCEEW	EIA	Environment Information Australia	**Environment Information Australia (EIA) supports various department functions with geospatial and imagery expertise, often relying on EO products.** EIA is Australia's first independent, national environmental data and information office to provide information to the independent Environment Protection Australia, the Government and the public.	$10,000,000 - $100,000,000	High
45	Federal	DCCEEW	EIA	Environment Information Australia audit for environmental assets	**Environment Information Australia will provide an audit on environmental assets across Australia.** Monitoring and assessing offset sites to ensure dedicated offset sites are used as described and not been impacted by developments or earthworks within the defined boundaries. EO can be used to capture changes in land use.	Less than $1,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
46	Federal	DCCEEW	CEWH	Environment Information Australia Ramsar wetlands	**Environment Information Australia uses Earth observation to map Ramsar wetland boundaries.** This project aims to map boundaries of Ramsar Wetlands, inundation and watering events for the Commonwealth Environmental Water Holder (CEWH).	Less than $1,000,000	High
47	Federal	DCCEEW	DCCEEW	Environment Compliance and Enforcement	**EO is used to monitor vegetation clearing events and breaches.** The Environment Compliance and Enforcement project aims to monitor and assess vegetation clearing events and breaches under the Environment Protection and Biodiversity Conservation (EPBC) Act legislation and its impact on Matters of National Environmental Significance (MNES).	Less than $1,000,000	High
48	Federal	DCCEEW	DCCEEW	Environmental Assessments (Nature Positive Regulations)	**EO is used as a regulatory tool for historic land use.** This project involves gaining environmental context, especially using time series for historic context, to review land use activities based on approval dates. This project requires data with consistent repeatability.	Less than $1,000,000	Medium
49	Federal	DCCEEW	EIA	Environment Information Australia for Ministerials	**EO could be used as supplementary material for Ministerial briefings.** This future project will revolve around providing contextual information in Ministerial briefing maps or compliance cases based on requests.	Less than $1,000,000	High
50	Federal	DCCEEW	EIA	Environment Information Australia for Emergency Management	**EO data, through Environmental Information Australia, is used to respond to emergency situations such as bushfires, flooding, cyclones.** EO data can be used to monitor disasters, assessment and can support disaster preparedness, and respond to emergency situations.	Less than $1,000,000	High
51	Federal	DCCEEW	DCCEEW	Biodiversity environmental products	**Satellite imagery is a fundamental enabling input to developing products on which DCCEEW relies heavily for environmental decisions and reporting.** These include the Habitat Condition Assessment System (developed by CSIRO), National Connectivity Index (developed by EIA using HCAS data), fire extent and fire severity mapping, flood mapping and flood erosion extents, etc. These products are used to infer direct impacts of interventions on species populations and habitats at locations, taking into account their regional and national contexts.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
52	Federal	DCCEEW	Parks Australia	National Parks Australia	**Using Landsat and Sentinel-2 data to map and monitor change in ecosystems, fire extent, and vegetation health.** Fine scale burning mapping using Landsat and Sentinel-2, generally mapping of fire extents and fire scars, identifying weeds and pests using AI (e.g., buffalo grass), ecosystem and vegetation health mapping and monitoring such as pig damage across floodplains, investigating hyperspectral satellite imagery to monitor changes over time (e.g., myrtle rust, pest and diseases, changes due to climate), planning to put more resources into climate monitoring likely by using satellite temperature and ocean data.	Less than $1,000,000	Medium
53	Federal	DCCEEW	CEWH	Commonwealth Environmental Water Holder	**Monitoring waterways and wetlands and vulnerability assessments.** Using satellite-derived datasets such as BoM climate outlook tool and QLD WetlandMap for monitoring waterways and wetlands, comparing historic changes of waterways and wetlands, monitoring outcomes of environmental watering, monitoring of Ramsar-listed wetland sites, assessing flooding extents, assessing vulnerability for use in determining Basin-scale environmental watering priorities (joint CEWH and Murray-Darling Basin Authority (MDBA) project, now used by MDBA), and creating time series GIFs for analyses and communications purposes.	Less than $1,000,000	High
54	Federal	DCCEEW	AAD	Australian Antarctic Division	**Monitoring ice, glaciers and coastline change in Antarctica.** Monitoring of ice, topographical mapping, mapping of changing coastline (ice shelves, glacier tongues, etc.), mapping glacier retreat, detecting crevasses, icebergs and their movements, sea ice mapping, counting of seals and penguin colonies, digitising coastlines, monitoring coastline changes and glacial retreats, glacier volumetric assessments, iceberg detection, time series analysis	Less than $1,000,000	High
55	Federal	DCCEEW		Chemicals and Atmosphere	**Monitoring chemicals in the atmosphere from satellite data.** Large potential to undertake atmospheric monitoring from satellite measurements, carbon emissions, methane emissions, aerosols, ozone, etc.	Less than $1,000,000	Low

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
56	Federal	DCCEEW		Chemical Management Branch	**Using earth observation to manage chemical contaminated sites.** Visual assessment and context of contaminated sites, confirming infrastructure and site facilities and providing advice to other Commonwealth agencies.	Less than $1,000,000	Low
57	Federal	DCCEEW		Waste and Resource Recovery	**Testing the use of satellite EO to monitor plastics pollution across Australia.** Planning to test the use of satellite EO data to monitor plastic and microplastic pollution in a range of Australian environments, which would allow for the large-scale mapping of waste plastics in marine, terrestrial and riverine environments.	Less than $1,000,000	Low
58	Federal	DCCEEW	EIA	Environment Information Australia	**Potentially using Earth observation to provide additional insights to ground water and soil moisture levels.** Not yet used but would like to introduce measurements from these satellites to support our line areas working in the space of water assessments, biodiversity, ecosystem health, fire and flood risk assessments and more, by providing additional insights to groundwater and soil moisture levels.	$10,000,000 - $100,000,000	Low
59	Federal	DCCEEW		National Landcare Program	**Satellite imagery to monitor vegetation growth and change for the 20 Million Trees Program.** The Australian Government invested $1 billion through the National Landcare Program's first 4 years from 2014-15 to 2017-18, including support for the Landcare Networks, 20 million trees and Australia's 56 regional natural resource management (NRM) organisations. The 20 million Trees Program was reviewed using satellite imagery to assess the effectiveness of the first phase of the program.	$100,000,000 - $1 billion	Low
60	Federal	DCCEEW	AAD	Australian Antarctic Division - biology program	**Using high resolution imagery to count seals and penguin colonies.** High resolution satellite imagery or aerial imagery can be used to count individual seals and penguins and colonies in remote or inaccessible areas. This can provide insights into health and stability of colonies and trends related to climate change or environmental factors, and aid in conservation efforts	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
61	Federal	DCCEEW	AAD	Australian Antarctic Division - expedition operations	**High resolution imagery to conduct safety field assessments in Antarctica.** Surface crevasses can be remotely mapped using synthetic aperture radar (SAR) on ice sheets and glaciers, as part of field landing assessments for expeditioner safety.	Less than $1,000,000	High
62	Federal	DCCEEW	AAD	Australian Antarctic Division - research group	**High resolution imagery is used to assess glacier volume and ice in Antarctica.** This project involves assessing glacier volume, presence and absence of ice, time series analysis using a series of open data sources, and synthetic aperture radar (SAR).	Less than $1,000,000	High
63	Federal	DISR	CDU, CER, DAFF, DCBR	Northern Australia Fire Information	**The North Australia and Rangelands Fire Information (NAFI) website provides satellite derived products for potential active fires, and burnt areas.** Active fires are shown via hotspots which are updated every few hours. Hotspots are produced from thermal (heat) sensors on a number of different satellites. They are usually accurate to within 1km of their actual location. Due to the way the heat image is converted into hotspot points, one large fire could show up as many hotspots or a number of smaller fires could appear as one hotspot. **Products**: Hotspots are sourced from Landgate Western Australia (from NOAA and NASA satellites) and Geoscience Australia (from NASA satellites).	$1,000,000 - $10,000,000	High
64	Federal	DISR	CSIRO	Fire Simulation (SPARK)	**Satellite information is used for input to SPARK fire simulation.** Spark is a toolkit for the end-to-end processing, simulation and analysis of wildfires. Users can design custom fire propagation models by building on Spark's computational fire propagation solver and incorporating various input, processing and visualisation components, each tailored for wildfire modelling.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
65	Federal	DISR	CSIRO	NovaSAR-1 program	**NovaSAR-1 is a small Synthetic Aperture Radar (SAR) mission and CSIRO has a 10% share of time.** The NovaSAR-1 satellite, developed by Surrey Satellite Technology Limited (SSTL) in the UK, utilises synthetic aperture radar (or SAR) which is an advanced form of radar technology providing extremely high-resolution images of Earth from space. CSIRO's Centre for Earth Observation operates Australia's share of NovaSAR-1 (10%) as a national research facility, providing Australian researchers the opportunity to task the satellite to acquire imagery in support of Research and development projects, with time awarded on a merit basis.	$10,000,000 - $100,000,000	High
66	Federal	DISR	CSIRO	TERN Landscapes	**The Terrestrial Ecosystem Research Network (TERN) brings together Earth observation research teams.** TERN's Landscape Monitoring platform conducts environmental monitoring and landscape observation using remote sensing techniques to characterise and monitor Australian ecosystems at a landscape and continental scale. The platform also undertakes modelling and synthesis activities to extrapolate and interpolate from observational data to produce modelled data products.	Less than $1,000,000	Medium
67	Federal	DISR	GA	Foundation Spatial Data	**Spatial and Earth observation data is used in the Foundational Spatial Data Framework (FSDF)**. FSDF provides a common reference for the assembly and maintenance of Australian and New Zealand foundation level spatial data in order to serve the widest possible variety of users. Geoscience Australia is the national custodian of a number of the foundation spatial data themes and datasets within the framework	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
68	Federal	DISR	GA	Digital Earth Australia	**DEA makes more than 30 years of landscape imagery and data from US and European satellites freely available for Australians** to see on interactive maps, to download, and to access via web tools and services. We process and provide national-scale imagery that shows Australian landscapes in unprecedented detail, revealing how our lands, waters, coasts and environments have changed over time. **Products**: DEA Waterbodies, DEA Coastlines, DEA Intertidal Elevation, DEA Mangroves, DEA Land Cover, ARD - Sentinel 1 and 2, DEA Water Observations, AusSpeccio Planned: DEA wetlands	$10,000,000 - $100,000,000	High
69	Federal	DISR	GA	Digital Earth Australia Hotspots	**Digital Earth Australia Hotspots uses satellite derived products to determine potential fire locations.** DEA Hotspots is a national bushfire monitoring system that provides timely information about hotspots to emergency service managers and critical infrastructure providers across Australia. Updated with new information every 10 minutes, the mapping system uses satellite sensors to detect areas producing high levels of infrared radiation (called Hotspots) accurately to allow users to identify potential fire locations with a possible risk to communities and property.	Less than $1,000,000	High
70	Federal	DISR	GA	Flood & Bushfire Insights subscription	**Using satellite products for emergency management (flood and bushfire)** GA, on behalf of the Commonwealth government, is procuring flood and bushfire insights products derived from SAR and/or EO data.	$1,000,000 - $10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
71	Federal	DISR	GA	Law of the Sea and Maritime Jurisdiction Project (Georegulation)	**Satellite and aerial data products are used to provide advice on maritime boundaries.** The Georegulation project defines Australia's national maritime boundaries, advises on the definition of administrative boundaries, and advises on geoscientific aspects of the Law of the Sea. The project also involves administration and enhancement of web-based information systems, in particular the Australian Marine Spatial Information System (AMSIS); provision of specific ad-hoc advice including provision of maps, coastal stability, written boundary descriptions and digital data to assist Government Agencies with regulatory authority in the Australian maritime jurisdiction; support to the Office of Transport Security on the definition of Security Regulated Ports; advice to Pacific Island Countries through SOPAC on maritime boundary related issues. Use of SecureWATCH, EO Mapper, Aerometrex, Geoimage. **Products used:** DEA Coastlines, NIDEM, ITEM, Low Water coastline delineation, LADS (Navy)	$1,000,000 - $10,000,000	High
72	Federal	DISR	GA	Australian Marine Spatial Information System	**AMSIS contains satellite derived information** and is a web based interactive mapping and decision support system that improves access to integrated government and non-government information in the Australian Marine Jurisdiction.	$1,000,000 - $10,000,000	High
73	Federal	DISR	GA	Australian Flood Risk Information Portal (AFRIP)	The Australian Flood Risk Information Portal (AFRIP) objective was to create a central online location where high-quality flood risk information is stored. Allowing access to current and readily available data would help emergency managers to raise awareness on flood risks and hazards around Australia. **Product**: DEA Waterbodies	Less than $1,000,000	Medium
74	Federal	DISR	GA	Digital Earth Africa	**Digital Earth Africa uses satellite observations for planning and monitoring** We equip government, industry and communities with organised, analysis ready data and high-performance computing infrastructure, unlocking the value of satellite observations for planning, monitoring and problem solving in Africa.	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
75	Federal	DISR	GA, AAD	Digital Earth Antarctica	**DE Antarctica will seek to use satellite imagery for monitoring land use and detecting change.** Station development and management across Antarctica, coastline change, Monitoring of territorial sovereignty, Safety of life through detection of crevasses, ice movement and changes in ice thickness, ice monitoring, security	$1,000,000 - $10,000,000	High
76	Federal	DISR	GA, CSIRO, Landgate, Bureau of Meteorology, ASA, WA Govt.	Australian National Ground Segment Technical Team (ANGSTT)	**The Australian National Ground Segment Technical Team will establish, operate and enhance a National Earth Observation Satellites ground network** that will provide access to data generated by satellites from a wide variety of government and potentially non-government sources.	Less than $1,000,000	High
77	Federal	DISR	GA, CSIRO, WA Landgate, NSW DPIE, Qld DES.	Copernicus Data Hub	**The Copernicus Australasia Regional Data Hub provides open access to data collected by the Sentinels.** Copernicus Data Hub, operated on behalf of GA. The Copernicus Australasia Regional Data Hub provides open access to data collected by the satellites of the European Union's Copernicus mission, covering Australasia, South-East Asia, the South Pacific, the Indian Ocean and the Australian Antarctic Territory.	$1,000,000 - $10,000,000	High
78	Federal	DISR	GA, DFES	WA tsunami modelling	**Using derived products from LiDAR and Satellite Derived Bathymetry to model tsunami inundation in WA** Using F133:F140 Onshore lidar DEM, gridded products WA Department of Transport, single beam and multibeam, SDB (NW shelf) (5m)	Less than $1,000,000	High
79	Federal	DISR	GA, NSW SES	NSW Coast Tsunami inundation modelling project	**Using derived products from LiDAR to model tsunami inundation in NSW** to inform hazard assessments by using bathymetry point clouds to define coastal features like breakwaters. **Products**: GA 5m lidar (onshore), 2018 bathymetry https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/89644	Less than $1,000,000	High
80	Federal	DISR	GA, QFES	Gladstone Inundation Modelling	**Using derived products from LiDAR to model tsunami inundation in Gladstone** Planned project	Less than $1,000,000	Low

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
81	Federal	DISR	CSIRO, Defence, Bureau of Meteorology	Bluelink/ OceanMaps	**Bluelink supports modelling efforts of the ocean floor to the surface to whole-of-ocean forecasting and reanalysis.** Services include forecasting capabilities for ocean circulation on scales ranging from global eddy-scales, regional shelf scales and littoral beach-scales, for the benefit of the Australian community, marine industry and Defence applications.	Less than $1,000,000	High
82	Federal	Home Affairs	NEMA	Disaster Assist	**Disaster Assist provides disaster recovery support via the provision of interactive maps which help people to find Local Government Areas affected by disasters.** Emergency Management Australia gives the Commonwealth the means to assist the States and Territories in major disasters particularly once the Commonwealth Disaster Plan is activated (COMDISPLAN). EMA has access to a range of resources used to detect, track, and mitigate emergencies, including data, images, satellite imagery, infrared monitoring, and mapping tools. EMA encourages an 'all agencies' and 'all hazards' approach to emergency management. The Australian Government is committed to supporting States and Territories in developing their capacity for dealing with emergencies and disasters and providing physical assistance to States or Territories during an emergency.	$10,000,000 - $100,000,000	Low
83	Federal	Home Affairs	Home Affairs	Security, surveillance and detection	**Satellite data to detect and monitor surveillance.** This programme is for the provision of civil maritime surveillance services, including the use of satellite data and other technologies to track and monitor ships and other vessels in Australian waters.	Greater than $1 billion	High
84	Jurisdiction	NSW	DPE	NSW Climate change fund Coastal hazard and risk	**LiDAR is used to map coastal hazard risks, and bathymetry.** This program is continuing for another 8 years for multibeam data capture to map sedimentary budgets in NSW, headlands and implications for sea level rise. It is part of the State Wide Mapping NSW Climate Change Fund	$1,000,000 - $10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
85	Jurisdiction	NSW	DPE	Mapping terrestrial and subtidal environments	**Using drones and aerial photography to map terrestrial, subtidal and beach environments**. Green lasers, drones, aerial photography and satellite imagery are used to survey terrestrial, subtidal and beach environments. Validation and calibration of high resolution techniques and imagery are used to validate against Sentinel data.	Less than $1,000,000	Medium
86	Jurisdiction	NSW	DPE	Climate change impacts on mangroves and saltmarsh and Inland mapping of the Murray Darling Basin Monitoring and Evaluation (Under MEMS)	**Using hyperspectral drones to map and monitor wetland condition and spectral signatures for macrophytes and saltmarsh** Seasonal studies using drones and satellite imagery to acquire spectral signatures for different macrophytes (mangroves), saltmarsh (lower and upper) to track time on condition extent. Mapping Murray Darling Basin wetland condition (Monitoring and evaluation)	$1,000,000 - $10,000,000	High
87	Jurisdiction	NSW	DPE	Integrated Marine Observing System (IMOS)	**Monitors and studies Australia's marine environment using Earth observation data from satellites, ocean buoys, and other platforms**. IMOS groups - SST, chlorophyll in operational capacities (planning fieldwork), EPA responses for sources of information, providing advice. Contributing to national wave archive along coast, wave model	Greater than $1 billion	High
88	Jurisdiction	NSW	DPE	Monitoring land clearing - early change monitoring of native vegetation	**The Native Vegetation Regulatory map identifies where native vegetation clearing for agriculture is regulated and based on satellite and aerial imagery**. Native vegetation regulatory map method statement describes the science and analytical processes used to develop the native vegetation regulatory map.	Less than $1,000,000	High
89	Jurisdiction	NSW	DPE	Statewide Landcover and Tree Study Program (SLATS-NSW)	**QLD SLATS program implemented in NSW** The main aim of the Statewide Landcover and Tree Study (SLATS) Program is to map the location and extent of woody vegetation loss each year. This information is then provided to land managers and policy makers for landcover monitoring and reporting. Hybrid data access and process (GEE (quick and free), AWS costs unsure, ground truthing surveys $$, spatial modelling with climate change, driven by open data access	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
90	Jurisdiction	NSW	DPE	Spatial Services	**Satellite imagery, designed to aid in management of resources and monitoring of oceanic and terrestrial changes**. imagery is available as part of Spatial Services SPOT 5/6/7 mosaics. So far two satellite imagery mosaics have been captured at 1.5m resolution (2019 and 2020) as part of the Spatial Services Whole-of-Government initiative.	Less than $1,000,000	Medium
91	Jurisdiction	NSW	DPE	Sharing and Enabling Environmental Data (SEED)	**The NSW Imagery web service uses a large selection of Landsat imagery across NSW Sharing and Enabling Environmental Data (SEED)** provides access to a repository of the Spatial Services (DCS) maintained standard imagery covering NSW, plus additional sourced imagery. It depicts an imagery map of NSW showing a selection of Landsat satellite imagery to 50cm	Less than $1,000,000	Medium
92	Jurisdiction	NSW	DPE	Marine Estate Management Strategy (MEMS)	**The MEMS includes >100 projects spanning 4 NSW govt departments using satellite, aerial, drone data**. The projects use EO in Climate Change projects, ranging from Sea Surface Temperature (SST), high resolution aerial imagery from NearMap or their own drones.	$100,000,000 - $1 billion	High
93	Jurisdiction	NSW	DPE	Marine Integrated Monitoring Program (MIMP)	**Aerial imagery will be used to monitor aquatic macrophytes (seagrass, mangroves and saltmarsh).** The marine integrated monitoring program will monitor marine habitats and biodiversity, assess the effectiveness of the MEMS and research to fill key knowledge gaps.	Less than $1,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
94	Jurisdiction	NSW	DPE, CSIRO	Mapping outflow events in NSW estuaries	**Using satellite imagery to measure coastal outflows on the effects of freshwater outflow events from NSW estuaries into our coastal environments**. A collaboration with CSIRO is using cloud computing (EASI platform) and satellite imagery to examine the size, frequency and distribution of coastal outflows over the NSW coast during the past two decades. We can then understand how water quality varies from region to region, and estuary to estuary to assess the risk of these events on offshore reefs and water column biodiversity, helping inform related management actions. 2 yr to continue. Outflows have more effect on fisheries. water quality. Griffith university review (2021-2020). no evidence to support contamination to the coastal zone. 20 yrs for data. neritic zone. regional. dashboard for govt. research. Marine parks, coastal councils, water authorities (desalination plants), aquaculture. SoE. Port Hacking only. AquaWatch. AI and modelling for prediction.	$1,000,000 - $10,000,000	High
95	Jurisdiction	NSW	DPE, UNSW, AODN	Terrestrial LiDAR to map the marine environment in NSW	**Using terrestrial LiDAR to map the marine environment** This project is run with NSW DPE and UNSW to combine terrestrially mapped marine data with ELVIS point cloud data, multibeam, AODN data, and delivered through the NSW SEED data portal	Less than $1,000,000	High
96	Jurisdiction	NSW	DPI	Mapping NSW estuarine macrophytes (repeat mapping)	**The program uses a variety of methods to map macrophytes, including aerial photography, satellite imagery, and ground-based surveys along the NSW coast**. The data collected is used to create spatial layers that can be used to track changes in the distribution of macrophytes over time through the NSW Department of Primary Industries.	Less than $1,000,000	Medium
97	Jurisdiction	NSW	DPI	National Greenhouse Gas Inventory - National Carbon Accounting (NSW)	**Mapping bare earth, woody vegetation using satellite** Spatial assessment monitoring and modelling time series for forestry, Planet Scope, SkySat (higher spatial resolution, but precision and rectification not as good - NSW has licence). Worldview 2 and 3 (US Defence - South China Sea). SEED and TERN as data portals. Councils use NSW Spatial Services - Statewide DTM using LiDAR.	$10,000,000 - $100,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
98	Jurisdiction	NSW	DPI, SCU	Shark Smart	**UAVs to detect sharks at NSW beaches** Unmanned aerial vehicles, often known as drones, offer emerging surveillance technology that provides aerial surveillance of coastal waters and real-time vision of the area.	Less than $1,000,000	High
99	Jurisdiction	NSW	GRDC, NSW DPI, CSIRO	Improving canola harvest management decisions with remote sensing	**Satellites used to inform canola harvests.** The project, 'Improving canola harvest management decisions with remote sensing', is investigating the accuracy of satellite and drone-based multispectral imagery sensing for better prediction of canola maturity and, therefore, the timing for optimal windrowing (and desiccation).	Less than $1,000,000	High
100	Jurisdiction	NSW	WaterNSW	Catchment reporting and monitoring	**EO is used in conjunction with other sampling techniques to monitor water quality and quantity.** WaterNSW is responsible for monitoring a significant part of the quality and quantity of NSW's raw water supply. They operate an extensive water quality and quantity monitoring program to track the raw water quality of both surface and groundwater sources. Monitoring includes physical, chemical, biological, radiological, hydrological and meteorological parameters through on-line instruments, field sampling and laboratory analysis.	Less than $1,000,000	Medium
101	Jurisdiction	NSW	DPI	Forest Resource Assessment	**Evaluate and adopt remote sensing technologies for forest monitoring** Improving the accuracy, efficiency and cost effectiveness of forest assessment over space and time, assessment and characterisation of plantation and native forest timber resources, forest growth modelling and wood quality assessment, assessment of socio-economic values for forests	Less than $1,000,000	High
102	Jurisdiction	NSW	DPI	Characterising native forest structure from co-incident terrestrial and airborne LiDAR	**Proof-of-Concept study to determine feasibility of Mobile Laser Scanning (MLS) with LiDAR** This project, funded in part by Forest Wood Products Australia (FWPA), investigated methods to link ground-based 3D point cloud LiDAR data with high-density aerial LiDAR and potentially satellite-based (GEDI) LiDAR data for the purpose of characterising the complex structure of moist eucalypt forests compared to manual collection methods. Report submitted to FWPA, FWPA project PNC546-2021 awaiting publication.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
103	Jurisdiction	NSW	DPI	NSW Forest Extent Interactive Reports	**Dashboards using Landsat-derived 20% canopy cover forest layer** NSW forest area by tenure across various key administrative boundaries for forestry activities and operations.	Less than $1,000,000	High
104	Jurisdiction	NSW	DPI, GA	Farm Dam Water assessment	**The Farm Dam Water assessment is the first ever widespread audit of farm dam conditions in NSW.** Through a collaboration between DPI and Geoscience Australia's Digital Earth Australia Program (DEA), the project maps water surface area of farm dams using high resolution remote sensing technology. Product: DEA Waterbodies	Less than $1,000,000	High
105	Jurisdiction	NT	DIPL	EO for emergency support (NT)	**EO used for intelligence and surveillance, disaster response and on-demand satellite tasking.** EO serves multiple critical purposes, including intelligence, surveillance, disaster response, and on-demand satellite tasking. It aids in monitoring and securing strategic locations, supports rapid disaster assessments, and provides adaptable, real-time data for various vital applications.	Less than $1,000,000	Medium
106	Jurisdiction	NT	DITT	EO4NT	**Earth observation 4 Northern Territory is an EO demonstrator program** grant to use DEA products and/or EO data and support for private company sectors in developing commercial applications derived from EO data that solve Territory business problems or enhance business performance and productivity. 1) CDU and NAFI to create high-resolution burnt area maps from EO 2) Maitec to use EO data to map pastures and measure grass biomass over NT savannah 3) Office of Planetary Observations to deliver an EO dashboard for urban greening insights to enhance city and urban planning	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
107	Jurisdiction	NT	NEMA, NTES	Trial Satellite Internet Across Tri-service Communications Network	**Using drones and satellite internet technology to assess disaster sites for emergency management response** This project will trial satellite internet technology across the tri-service communications network and connectivity with drones to assess disaster sites to obtain critical incident information. This will enhance critical incident information capabilities for emergency management responses.	Less than $1,000,000	High
108	Federal	PM&C	NIAA	Indigenous Rangers Program	**Drones are used to map and monitor environmental change.** The Indigenous Rangers Program (IRP) assists First Nations people to manage the Country in accordance with Traditional Owners' objectives. Indigenous rangers use traditional knowledge and cultural practices, combined with western science, to manage land, river and sea Country and deliver environmental, cultural, social and economic development outcomes. Drones are often used by Indigenous rangers and their partners to map and monitor specific sites to assess changes over time, particularly before and after management actions.	$100,000,000 - $1 billion	High
109	Jurisdiction	QLD	DES	Land use mapping (QLUMP)	**Maps and assesses land use patterns and changes across the state using satellite imagery and complementary data.** This program uses the Australian Collaborative Land Use and Management Program methodology to describe what the land is used for.	Less than $1,000,000	Medium
110	Jurisdiction	QLD	DES	Ground Cover Monitoring	**Using satellite imagery to measure and monitor ground cover across Queensland**. By analysing the imagery, the scientists can investigate how areas of ground cover and bare soil surface change through time and space.	Less than $1,000,000	High
111	Jurisdiction	QLD	DES	Crop Monitoring	**Using satellite imagery to detect the growth of broadacre crops in Queensland** Broadacre crops (cotton, sugar cane and 'other') have been mapped twice a year since 1988 using Landsat, Sentinel-2 and MODIS.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
112	Jurisdiction	QLD	DES	AussieGRASS	**The AussieGRASS model monitors key biophysical processes associated with pasture growth (i.e., degradation and recovery) at regional scales (e.g., local government areas or bioregions).** AussieGRASS provides long-term time-series of rainfall and pasture growth information, as well as projections for the season ahead, which are useful for forage budgeting, assessing the impacts of drought, and bushfire risk.	Less than $1,000,000	High
113	Jurisdiction	QLD	DES	FORAGE (report delivery system)	**FORAGE incorporates a number of products such as SILO climate data, satellite imagery and modelled pasture growth**, delivering them by email as easy to understand PDF property-scale reports, to help decision-making in grazing land and environmental management. FORAGE is an online system that generates and distributes, in custom PDF reports, information for rural Lots on Plan greater than 1 hectare in area.	Less than $1,000,000	High
114	Jurisdiction	QLD	DES	Regional Ecosystems	**Earth observation data is used to derive regional ecosystem descriptions at a statewide level in QLD.** Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.	Less than $1,000,000	High
115	Jurisdiction	QLD	DES	Spatial BioCondition	**Using machine learning to integrate site-based vegetation condition assessment methods and remote sensing land cover data**, the framework predicts how well the vegetation maintains the biodiversity values in each ecosystem. Spatial BioCondition (SBC) is a modelling and mapping framework that is used to predict and map the condition of vegetation in most of Queensland's regional ecosystems.	Less than $1,000,000	High
116	Jurisdiction	QLD	DES	Wetland Mapping	**EO is used to map wetlands in Queensland.** Wetland Summary provides interactive maps, summaries of wetland information, management guides, case studies and relevant legislation. Wetlands have been mapped digitally by building on existing information including water body mapping derived from satellite imagery, regional ecosystem mapping, waterholes data and watercourse lines from topographic mapping.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
117	Jurisdiction	QLD	DES, QHBS, DR, JRSRP	Statewide Landcover and Trees Study (SLATS)	**Satellite imagery to monitor changes in woody vegetation extent** Satellite imagery and field data are used to monitor and report changes in woody vegetation extent in Queensland and provide information about other woody vegetation attributes such as foliage density and age since disturbance. SLATS monitors native woody vegetation, which is critical for maintaining biodiversity, preventing land degradation and improving water quality.	Less than $1,000,000	High
118	Jurisdiction	QLD	DES, RSS, JRSRP	Fire Scar Mapping	**Using satellite imagery to automatically detect fire scars** Remote Sensing Sciences, in partnership with the Joint Remote Sensing Research Program, has developed methods to map historical and recent fire scars using Landsat and Sentinel-2 satellite imagery. These fire scar mapping products capture the detailed fire history across Queensland from 1986 onwards**.**	Less than $1,000,000	High
119	Jurisdiction	QLD	NEMA, DES	Coastal and Estuarine Risk Mitigation program (CERMP)	**State-wide nearshore bathymetry survey for improved coastal hazard assessment** This project will capture high-resolution nearshore bathymetry using airborne sensors, and near coast land levels along developed sections of the Queensland coast, significantly improving State and Local Council ability to risk assess coastal hazards.	$1,000,000 - $10,000,000	High
120	Jurisdiction	QLD	NEMA, QRA	Statewide disaster ready Fund	**This project will improve the coverage and availability of Disaster Ready Imagery across Queensland.** The Disaster Ready Fund program is aimed at improving Australia's resilience and reducing risk to natural disasters	$1,000,000 - $10,000,000	High
121	Jurisdiction	SA	DEW	EO for emergency support (SA)	**EO used for intelligence and surveillance, disaster response and on-demand satellite tasking.** EO serves multiple critical purposes, including intelligence, surveillance, disaster response, and on-demand satellite tasking. It aids in monitoring and securing strategic locations, supports rapid disaster assessments, and provides adaptable, real-time data for various vital applications.	Less than $1,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
122	Jurisdiction	SA	NEMA, SAFECOM	Forecasting Ground Displacements Future Earthquakes	**Satellite data and aerial vehicles to map tectonically active faults near infrastructure**. This project will use geospatial data obtained from aerial vehicles, satellites and field studies to map tectonically active faults near major infrastructure projects in South Australia (Franklin Harbour, Cleve, Whyalla)	$1,000,000 - $10,000,000	High
123	Jurisdiction	TAS	NEMA, RRT, DP&C		**Early warning system with live data and visual intelligence for floods** This project will develop an early warning detection system to provide live data and visual intelligence. This will address gaps identified during recent floods and is expected to allow more time for critical operational decisions.	Less than $1,000,000	High
124	Federal	Treasury	ABS	Agricultural census data	**Datasets that improve agricultural crop statistics using satellite data.** The Australian Bureau of Statistics (ABS) is working to modernise the way we produce agriculture statistics to quickly deliver information at regional scales and enable a holistic understanding of agriculture together with the environment and regional communities. Digital Earth Australia (DEA) is the platform that stores satellite data for Australia from which maps on crop and land cover can be created. The DEA infrastructure is hosted by Geoscience Australia.	$10,000,000 - $100,000,000	Medium
125	Jurisdiction	VIC	DECCA	Forest Fire Management Victoria (FFMVic)	**EO is used for fire risk management and biodiversity studies.** Biodiversity studies to determine flora and fauna composition for monitoring purposes. Biodiversity information products can be used to understand the biodiversity value of native vegetation when undertaking strategic planning for biodiversity protection and management. FFMVic uses satellite remote sensing for fire risk management. EO offers precise and frequent data, which is particularly valuable in areas that lack reliable national data on fire risk	$10,000,000 - $100,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
126	Jurisdiction	VIC	DECCA	Reducing Bushfire Risk Management	**EO satellite data are used for planning and monitoring purposes.** The Joint Fuel Management program and the Strategic Fuel breaks program are likely to use Earth observation to strengthen and expand Victoria's network of fuel breaks, as well as managing fuel on public and private land.	$10,000,000 - $100,000,000	High
127	Jurisdiction	VIC	DECCA, Conservation Regulator	Regulatory and compliance	**EO is used to detect and monitor timber harvest areas in Victoria**. Algorithm developments are used to detect change in satellite data (e.g., timber harvest detection).	Less than $1,000,000	High
128	Jurisdiction	VIC	DOTP	Victorian Coordinated Imagery Program (Vicmap)	**Public sector access to Victoria's archive of aerial imagery.** The Victorian Coordinated Imagery Program (CIP) coordinates the purchase of aerial imagery and elevation products across Victoria and facilitates access to existing imagery and elevation products in the CIP archive for a wide range of public organisations. This data supports planning, emergency response, environmental research and government programs across Victoria.	$10,000,000 - $100,000,000	High
129	Jurisdiction	VIC	DOTP	Victorian Emergency Management - State Control Centre	**Satellite and synthetic Aperture Radar data is used to detect flood waters.** High Resolution commercial data at 3m resolution is used to support emergency response and situational awareness planning.	$10,000,000 - $100,000,000	High
130	Jurisdiction	VIC	NEMA, EMV	Remote Bushfire Detection	**Rapid Identification of bushfire ignition using satellite and terrestrial camera technology** This project seeks to provide rapid identification of bushfire ignitions using satellite and terrestrial camera technology integrated with machine learning. Early detection allows a quicker response to ignitions, reduces the impacts of bushfire on people, property, and the environment, increases first responder safety and reduces the cost of suppression.	$1,000,000 - $10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
131	Jurisdiction	VIC	NEMA, EMV	Victorian LiDAR flood mapping	**Flood mapping using LiDAR to inform flood modelling** This study will provide flood mapping for the entire municipality to reduce flood risks. Previous scoping has identified the need for LiDAR (Light Detection and Ranging) data. This project will acquire LiDAR data through the Statewide Digital Twin Victoria (DTV) and Coordinated Imagery Program (CIP) to inform flood modelling in the next stages of the flood study.	Less than $1,000,000	High
132	Jurisdiction	WA	DBCA	Fire Mapping and Modelling	**Using Earth observation to map locations of fire in Western Australia**. The mapping and locations of fire patterns within the Department Biodiversity, Conservation and Attractions Estate. Information on precise fire boundaries, burn intensities and occurrences are vital for fire management and understanding	Less than $1,000,000	High
133	Jurisdiction	WA	DBCA	Marine Mapping and Monitoring	**Monitoring Marine Protected Areas and associated fauna**. Monitoring, with evaluation and reporting, is the key feedback mechanism in a 'best practice' natural resource adaptive management approach. Hence, it is primarily the responsibility of management agencies. Monitoring, for measuring success of management actions towards objectives (of Marine Protected Areas management plans and marine fauna conservation programs) and for applying active adaptive management principles to marine conservation, will be a priority for WA's marine science program.	$1,000,000 - $10,000,000	Low
134	Jurisdiction	WA	DBCA	Vegetation Monitoring	**Managing imagery for vegetation monitoring.** Key Department of Biodiversity, Conservation and Attractions (DBCA) responsibilities include broad roles in conserving biodiversity and protecting, managing, regulating and assessing many aspects of the use of the State's natural resources. Many operational tasks require ongoing accepted monitoring procedures that use consistent, repeatable imagery.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
135	Jurisdiction	WA	DMIRS	Land Audit and Compliance: DMIRS legislation	**Using Earth observation for audit and compliance of responsibilities under Department of Mines, Industry Regulation and Safety (DMIRS) legislation.** DMIRS is responsible for regulating mining, petroleum, and geothermal activities, and uses aerial photography and satellite imagery where appropriate, to capture native vegetation extent.	Less than $1,000,000	Medium
136	Jurisdiction	WA	DMIRS	Land Audit and Compliance: Land subsidence in Collie Coal fields	**Use of imagery to detect land subsidence in Collie Coal fields.** The identification of land subsidence in the Collie Coal fields through potential activities such as mining, can result in ground depressions or uneven terrain. This information is required for environmental assessment and assuring safety and sustainability of mining operations in the Collie Coal fields.	Less than $1,000,000	High
137	Jurisdiction	WA	DMIRS	Land Audit and Compliance: tailings storage facilities	**Use of imagery to detect movement in abandoned tailings storage facilities** Identification of movement in abandoned tailings storage facilities is important in managing, as unmaintained storage and movement of these facilities can lead to safety, health and environmental hazards.	Less than $1,000,000	High
138	Jurisdiction	WA	DMIRS	Land Audit and Compliance: Fires in Collie Coal fields	**Use of imagery to detect subterranean fires in the Collie Coal fields**. Identification of subterranean fires in Collie Coal fields is important for environmental monitoring and safety in the region. Subterranean fires can potentially release harmful gases and cause land subsidence. Identification and mitigation are essential to prevent environmental damage	Less than $1,000,000	High
139	Jurisdiction	WA	DOT	WA Coastline and bathymetric capture	**Using Earth observation to capture bathymetry and monitor the WA coastline.** Monitoring movement of the WA coastline and near shore bathymetry to inform risk assessments associated with climate change.	$1,000,000 - $10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
140	Jurisdiction	WA	DPIRD	Monitoring Salinity	**Monitoring salt-affected and low productivity land using Landsat.** The Land Monitor Project produces maps based on Landsat data of the extent and change in areas of salt-affected/persistent low productivity land. Spatial resolution is 25 m by 25 m. The project covers the entire SW agricultural area (24 million hectares). Accuracy assessments of salinity mapping are carried out and published for sample areas within each region.	$1,000,000 - $10,000,000	High
141	Jurisdiction	WA	DPIRD	Illegal Drains in SW WA	**Satellite imagery is used to determine illegal drain locations in SW WA.** This project involves mapping the locations of unapproved drains in the SW of WA. This effort is essential for environmental conservation and land management, helping to address potential issues related to water quality, land degradation, and sustainable land use practices in the region.	Less than $1,000,000	High
142	Jurisdiction	WA	DPIRD, Landgate	Pastoral Remote Sensing	**The Pastoral Remote Sensing (PRS) application is based on satellite imagery.** PRS provides mapping tools and estimates of cumulative rainfall, total green biomass, total dry matter and normalised difference vegetation index (NDVI) for every pastoral lease in Western Australia.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
143	Jurisdiction	WA	DPLH	Urban Monitor	**Urban Monitor (UM) provides mapped data of the urban tree canopy for the Perth and Peel Regions in Western Australia** under the Better Urban Forest program. Core products include digital ortho-photo, vegetation cover, vegetation vigour, vegetation height, ground elevation, surface elevation and a combination of the above through a normalised elevation model and vegetation cover to achieve the layers of grass, trees and shrubs. The UM products were developed by the Data 61 team at the CSIRO for the Department of Planning, Lands and Heritage (DPLH) on behalf of the Western Australian Planning Commission (WAPC). The Urban Growth Monitor is a component of the DPLH's Urban Development Program for the WAPC to fulfil its requirements for tracking and modelling land supply as outlined in the Planning and Development Act 2005. Capture of aerial photos, web-map services, coordination of the consortium and distribution of UM products is done by Landgate.	Less than $1,000,000	High
144	Jurisdiction	WA	DWER	Land Audit and Compliance	**Audit and compliance of native vegetation using Earth observation**. Appropriate image sets are sighted to check native vegetation compliance with appropriate applications. Major focus has been within the SW but development occurring to the rest of the State.	Less than $1,000,000	Medium
145	Jurisdiction	WA	DWER, DCBA, Landgate, DPIRD, DPLH, DFES, DMIRS	WAVE (WA Native Vegetation Extent)	**The Western Australian native vegetation extent dataset (WAVE) provides Identification of remnant vegetation and condition across WA** including a new regularly updated dataset and monitoring system, leveraging remote sensing and machine learning. This includes publicly available satellite data for other purposes as well, such as tracking land clearing over time.	$1,000,000 - $10,000,000	High
146	Jurisdiction	WA	FPC	Forest Health (WA)	**Monitoring the health of forest stands in Western Australia using remote sensing.** The Forest Products Commission Management is responsible for tracking the health of forest stands. Satellite imagery was used to compare plantation canopy levels from year to year to determine any decline.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
147	Jurisdiction	WA	Landgate	Pastures from Space	**Landgate in Western Australia operates a service to agriculture known as Pastures from Space using EO data to inform pasture growth rates**. This service along with relevant software provides paddock scale data on pasture growth rates (PGR) and food on offer. This is used by farmers to estimate stocking rates and predict productivity trends. It operates in Southern Australia and is being developed to supply data in the Kimberley's in Western Australia. Landgate is developing products that will enable biomass analysis for weed detection and germination.	Less than $1,000,000	High
148	Jurisdiction	WA	Landgate	FloodMap Program	**FloodMap provides emergency services personnel with satellite datasets and an online map to help in the management and mitigation of floods over Australia.** Datasets include current surface water derived from MODIS, historical flooding, flood risk products and also storm surge modelling.	Less than $1,000,000	High
149	Jurisdiction	WA	Landgate	OceanWatch Program	**Providing an application to view Sea surface temperature, turbidity and chlorophyll data for WA.** OceanWatch provides access to sea surface temperature, optical attenuation, and chlorophyll products and in the future, a range of other satellite derived ocean products.	Less than $1,000,000	High
150	Jurisdiction	WA	Landgate	VegetationWatch Program	**VegetationWatch produces greenness image maps over Australia.** MODIS and NOAA satellite images are processed to provide greenness images at 250m and 1km resolution. Greenness images from MODIS are available within 3 hours of the overpass and a fortnightly composite over Australia is available weekly. (Underpins other programs)	Less than $1,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
151	Jurisdiction	WA	Landgate	WALIS	**The Western Australian Land Information System (WALIS) used to share and manage spatial data, including aerial photography and satellite imagery.** WALIS is a partnership of government agencies working with business, education and the general community to manage and promote the State's geographic information. Data captured through the State Land Information Capture Program (SLICP) can range from aerial photography, topographic data, satellite imagery, bathymetry, LIDAR, infrastructure, to 3D surveys, soils, ortho-imagery and any other type of spatial data required. The data requested through SLICP provides an opportunity to drive decision making on important issues such as climate change, planning, mining and health.	$1,000,000 - $10,000,000	Medium
152	Jurisdiction	WA	Landgate	Soil Grade Mapping	**Identification of soil grades for valuation purposes in regional WA (SW corner)**. Soil grading and identification can be valuable for assessing land quality and potential future use and value. Soils are classified based on their properties such as texture, organic matter content and nutrient levels. This, combined with data derived from satellite imagery provides important land use planning decisions.	Less than $1,000,000	High
153	Jurisdiction	WA	Landgate	Farm Dams locations - SW WA	**Satellite imagery and machine learning is used to determine farm dams in South-west Western Australia.** These maps provide valuable insights to regional land management and planning.	$1,000,000 - $10,000,000	High
154	Jurisdiction	WA	Landgate	Building locations	**Satellite imagery and machine learning is used to determine the location of all structures in WA.** This innovative approach offers a comprehensive view of the state's built environment, facilitating better planning, resource allocation, and infrastructure management.	$1,000,000 - $10,000,000	High
155	Jurisdiction	WA	Landgate	CaptureWA	**CaptureWA coordinates and shares spatial data from Western Australia.** The program coordinates the capture and sharing of different types of location data from across WA - from aerial and satellite imagery, to LiDAR, DEMs, cadastral, topographic data, and more. The program continues to expand and evolve to balance the delivery of emerging technology with cost-effective solutions.	$1,000,000 - $10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
156	Jurisdiction	WA	Landgate, CDU	Landgate FireWatch	**Satellite imagery is an important component of fire management**. The FireWatch map service provides emergency services personnel with an online map application to help in the management of bushfires over Australia. Datasets include fire hotspots, burnt area maps since 1997, greenness images updated daily and weekly, lightning data and other useful map layers.	$1,000,000 - $10,000,000	High
157	Jurisdiction	WA	Landgate, CSIRO, DBCA, DPLH, DWER, Water Corp, DFES	Land Monitor Project	**Monitoring vegetation across all of WA.** Land Monitor is a coordinated initiative originally under the National Dryland Salinity Program. The project originally aimed to systematically monitor salt-affected land and remnant vegetation change over the agricultural area of southwest of Western Australia. Land Monitor phase III is aimed at vegetation monitoring on an annual basis across all of WA.	Less than $1,000,000	Medium
158	Jurisdiction	WA	Landgate, DFES	Emergency management	**Earth observation is used to assist in emergency management planning and decision making.** Operational staff use the Shared Land Information Platform Emergency Management (SLIP-EM) services to assist decision making during incidents. The WA emergency management community in collaboration with strategic information providers (i.e., Bureau of Meteorology, Landgate and others) collaborated in the development of SLIP-EM to ensure each agency is able to effectively share authoritative and current spatial information.	$1,000,000 - $10,000,000	Medium
159	Jurisdiction	WA	Landgate, DPIRD	WA Coastline Identification	**Sentinel-2 data is used to track movement of the WA coastline over time.** Coastline information is used to inform coastal planning and management decisions. The project helps to understand coastal dynamics and can potentially identify areas that are at risk of erosion or inundation.	Less than $1,000,000	High
160	Jurisdiction	WA	Landgate, DPIRD	Oil Mallee Plantations	**Use of EO-derived datasets to produce a reliable map of Oil Mallee Plantations in SW WA**. The datasets can be used to assess environmental impact of the plantations, growth, health assessment and identify areas of potential degradation**.**	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
161	Jurisdiction	WA	Water Corporation	Vegetation Monitoring (Perth catchments)	**Land Monitor products provide mid-scale monitoring of vegetation** and are used to gain understanding on vegetation dynamics and its effect on water yield in Perth dam catchments.	Less than $1,000,000	Medium
162	Jurisdiction	WA	Water Corporation	Vegetation Monitoring and cover estimates	**High resolution airborne multi-spectral imagery are used to evaluate change in forest cover.** The Vegetation Monitoring and cover project estimates forest cover change and evaluates the effectiveness of forest management across Western Australia.	Less than $1,000,000	High
163	Federal	DCCEEW	Bureau of Meteorology, CSIRO	Australian Water Outlook	**Satellite based estimates of vegetation and terrestrial water storage i**s used in the Australian Water Resource Assessment Landscape model (AWRA-L). AWRA-L is a daily 0.05° grid-based, distributed water balance model, conceptualised as a small unimpaired catchment.	Less than $1,000,000	High
164	Jurisdiction	SA	SA DEW, SA DFES, UA, RMIT, Shoal Engineering	Adaptive Analytical Tool for better understanding and reducing future bushfire risk	**EO data can assist with identifying how bushfire likelihood can change in space and time,** allowing more informed and transparent decision-making for reducing bushfire risk. The project will develop an analytical tool – the Adaptive Analytical Bushfire Likelihood (AABL) Tool – that utilises EO data such as vegetation, soil moisture, meteorological and climatic variables as inputs to a model to map the spatial and temporal distribution of bushfire likelihood. Working with our end users – the SA and WA government – the tool will deliver a new suite of analytical and modelling capabilities and information dashboards that can integrate with and support these State Governments' Bushfire planning strategy.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
165	Jurisdiction	ACT	ANU, UNSW, Skykraft, LatConnect 60, Spiral Blue, GA	OzFuel (Australian Fuel Monitoring from Space) Phase A	**OzFuel is a bushfire mitigation satellite mission aimed at delivering fuel hazard** remote sensing data for downstream Earth observation data analytics services, with the goal of improving Australia's pre-fire monitoring, prediction, preparation, response and resilience. From Low Earth Orbit (LEO), OzFuel will acquire spatial data on fuel conditions such as dry mass and moisture content, tuned specifically to Australia's Eucalypt-dominant forests. This data will be tested within data services such as the Australian Flammability Monitoring System, which is used by agencies for pre-season planning (identifying areas in the landscape where a fire may ignite and spread for prescribed burns) and response (deciding what areas should be prioritised when sending resources and equipment)	Less than $1,000,000	High
166	Federal	DISR	CSIRO, QLD DAF, WA DWER	AquaWatch coastal water quality pilot	**Integration of satellite and in situ observations with ecosystem modelling data streams for water quality understanding in two coastal ecosystems.** This pilot project aims to establish the AquaWatch system's effectiveness for Australian coastal waters on a small scale. It utilizes new partnerships with regional water managers to integrate and visualize various space-based and ground-based water quality data streams, along with hydrodynamic model outputs. The outcome will be a demonstrator ground-to-space water quality monitoring tool with a prototype visualization dashboard. The long-term goals include developing new sensor technologies, software platforms, and packaged products. The ultimate aim is to demonstrate the integrated technologies' value, benefits, and adoption potential, which will inform the AquaWatch mission's development. The results will inform relevant industry sectors for commercial development, benefiting the Australian economy.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
167	Federal	DCCEEW	CSIRO, LTU	Machine Learning for AquaWatch Water Quality parameter mapping	**Using machine learning (ML)-based algorithms and models to decouple the complex optical signature in coastal waters and deriving water quality parameters in coastal waters from satellite observations.** Through collaborating with CSIRO researchers and our industry partners, this project will investigate the potential of new machine learning approaches in predicting water quality parameters through fusing data from in situ water quality sensors and satellite observational data. We will develop a machine learning model to invert the remote sensing reflectance signal and to derive WQ parameters. The result will be a machine learning-based modelling tool to improve the water quality products and thus enable better coastal ecosystem management. New ML-based remote sensing products from this project will help end users in the Cockburn Sound and Moreton Bay regions improve their coastal monitoring and management practices.	Less than $1,000,000	High
168	Federal	DISR	Uni SA, SUT, GA	Small satellite energy-efficient on-board AI processing of hyperspectral imagery for early fire-smoke detection	**Energy-efficient AI-based on-board processing of hyperspectral imagery supporting automated early detection of fire smoke.** We propose using modified and resampled MODIS imagery data that emulates the swath as well as spectral, spatial, and radiometric resolution of HyperScout-2 channel 1 hyperspectral imagery. In doing so, we intend to provide a solution that meets on-board processing limitations and up/downlink data transfer restrictions of the Kanyini – HyperScout-2/ with Intel's Myriad X VPU chip. Expected outputs include on-board and ground AI algorithms for fire smoke detection, applicable for various hyperspectral imagery datasets.	Less than $1,000,000	High
169	Federal	DISR	RMIT, SA Govt., DEWLP, GA, CDU, NSW RFS	Real-time Fire Analytics	**A satellite system of systems encompassing geostationary, polar orbiting and aerial based sensors for real time fire landscape attribution.** The project will design and deliver a data and platform ecosystem to allow autonomous real time information on fire to be detected, processed and delivered to end users.	Less than $1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/ Product Name	Description	Total program scale	EO dependency
170	Jurisdiction	VIC	DECCA, EMV	Satellite tasking during emergency events in VIC	**Satellite tasking during emergency events** DECCA are working with Emergency Management Victoria to provide them with self-service access to tasking satellites for data capture predominantly for fire and flood events, with the potential for earthquakes. Satellite data has been used to track flood pulse downstream to the ocean and state borders in summer 2022. Data has been used in conjunction with stakeholder engagement to determine government asset impact, as well as linked with 3D building datasets to determine freehold land and housing impact from floods.	Less than $1,000,000	High
171	Federal	DAFF	GRDC, Data Farming	CropPhen	**CropPhen: A digital tool to remotely map grain crop type and phenology stage across environments.** The CropPhen digital tool will be delivered to industry via a national commercial partner and be able to map crop phenology per crop across multiple fields and farms, using hyperspectral data from ground sensors, UAV and satellites.	$1,000,000 - $10,000,000	High

Appendix D: Survey and Interview Questions

Risks to Continuity of EO Data Supply for Australia: Satellite EO Data Use Overview Survey Questions

About Your Organisation

In this Section, we are seeking to understand where your organisation sits in the Australian Earth observation ecosystem.

1. **What is the name of your organisation?** *(Please indicate your organisation so we can attribute your responses.)*

2. **Is your organisation?** *(Please indicate the type of your organisation. Check all that apply.)*

   - Government
   - Industry / Private
   - Academic / Research
   - Non-Governmental Organisation (NGO)
   - Other:

3. **If government, which government?** (*Mark only one oval.)*

   - Commonwealth
   - QLD
   - NSW
   - VIC
   - ACT
   - TAS
   - SA
   - NT
   - WA
   - Australian Local
   - Not government
   - Other:

4. **What sector(s) or thematic area(s) is your organisation currently active in?** (Please indicate all applicable areas and add additional areas via the 'other' option as required. *Check all that apply.)*

   - Weather and climate
   - Environment / carbon monitoring
   - Agriculture and primary production
   - Disaster response and management
   - Urban planning and development
   - Mining and resource exploration
   - Land and natural resource management
   - Ocean and coasts
   - Freshwater monitoring

- Data supply
- EO data exploitation and platforms
- Consulting
- Technology and Research and Development
- Banking, financial services, and insurance
- Other:

Current Satellite Data Usage

In this section we are trying to understand the current status and order of magnitude of your organisation's satellite data usage.

5. **Is your organisation currently using satellite Earth observation data in your application/s?** (*Mark only one oval.)*

- Yes, we are currently using or providing satellite EO data
- We plan to use satellite EO data in the future
- We are evaluating the use of satellite EO data for future work
- We have used satellite EO data in the past
- Other:

6. **Please briefly list any specific application/s where you are using satellite EO data.**

(Satellite EO-related projects, products, or services to better understand your use cases, e.g., crop monitoring, DEA Coastlines, sea level monitoring, etc.)

7. **How would you describe your organisation's use of satellite EO data?** *(Try to focus on your primary use but select all that apply. Check all that apply.)*

- Acquisition, i.e., tasking a satellite to capture data
- Supply, i.e., supplying raw or processed satellite data to others
- Processing, i.e., providing satellite-derived products (e.g., maps, reporting)
- Analysis, i.e., deriving value added information products (e.g., impact assessments, operational products)
- End-user, i.e., receiving satellite-derived information or products
- Other:

8. **How frequently do you use or plan to use satellite EO data or derived datasets?** *(Mark only one oval.)*

- Daily
- Multiple times a month
- Monthly
- Quarterly
- Annually
- Seasonally
- Specific Events (e.g., natural disaster)
- Other:

Data Sources and Types

In this section we are trying to understand the sources and types of EO data you are currently using, or plan to use.

9. **Please briefly list any specific satellite EO data sources you currently use, e.g., Landsat 9, Sentinel-2, WorldView 3, etc.** *(Include the data sources as your organisation refers to them, e.g., satellite name, instrument name, satellite data product name, etc.)*

10. **What types of satellite data do you use or intend to use?** *(Check all that apply.)*

- Raw satellite data
- Processed satellite data (e.g., surface reflectance, top of atmosphere)
- Derived products (e.g., landcover)
- Don't know
- Other:

11. **Please select all of the data types you use or plan to use:** *(Check all that apply.)*

- coarse resolution optical (> 100m)
- Medium resolution optical (10-100m)
- Fine resolution optical (1-10m)
- Very fine resolution optical (<1m)
- Hyperspectral data or imagery
- Synthetic aperture radar (SAR)
- Soundings
- GNSS-RO
- Radar altimetry
- Imaging multi-spectral radiometers (passive microwave)
- Imaging multi-spectral radiometers (vis/IR)
- Scatterometry
- Magnetometry
- All of the above
- Other:

12. **Are there any challenges that you have with the use of satellite EO data?**

(Current or historical, and as a possible list of topics for a follow-up discussion or any additional comments)

13. **Point of Contact (name, email) (optional)**

Risks to Continuity of EO Data Supply for Australia: Applications and Data Requirements

Application

What is the size, shape, and EO dependency of your application?

1. **What is the name of your organisation?**
2. **What is the name of your application?**
3. **Could you provide a short description of your EO application?** *(A link to a description is fine.)*
4. **Application domain:** *(Check all that apply.)*
   - Government
   - Research and Development
   - Academic
   - Commercial
   - Other:
5. **Application type:** *(Check all that apply.)*
   - Project or Study - discrete time frame
   - Project or Study - open ended time frame
   - Product - one off
   - Service - ongoing
   - Future - to be determined
   - Other:
6. **Application start date:** *(Month and year, or year.)*
7. **Application end date:** *(Month and year, or year.)*
8. **Total project operational annual budget range:** *(Mark only one oval.)*
   - Under $10,000
   - $10,000 to $100,000
   - $100,000 to $500,000
   - $500,000 to $1,000,000
   - $1,000,000 to $10,000,000
   - $10,000,000 plus
9. **Is there a specific budget for satellite EO?** *(If so, please specify an approximate dollar amount.)*
10. **Is there a revenue stream associated with this application?** *(If so, please specify to the level of detail possible.)*
11. **Number of full time equivalent (FTE) people involved in delivering the application:**
12. **Would you like to add a data requirement for this application?** * *(Mark only one oval.)*
    - Yes *Skip to question 13*
    - No Skip to question 122

Satellite EO Data Requirement #1

We are hoping to better understand the satellite EO data requirements for this application, and are seeking information in four different areas:

- *Requirement name and data type*
- *Spatial resolution*
- *Spectral resolution*
- *Temporal resolution and latency*

For data requirements we are seeking to understand:

- *Threshold requirements i.e., the MINIMUM that is needed for the application.*
- *Target requirements i.e., the IDEAL; where you would like to be. Some data sources may be able to meet these already.*

(If additional requirements need to be specified, up to five can be added.)

Requirement Name and Data Type

This section is providing contextual information and exploring the type of data required.

13. **What is the name of this satellite EO data requirement?** *(Please provide a handle we can use to describe the requirement if applicable, e.g., Radar for Soil Moisture, Soundings for GHGs, etc.)*
14. **How is this satellite EO data used in your application?** *(e.g., land-use monitoring, weather forecasting, disaster management)*
15. **What is the start date for this requirement?** *(Month and year, or year.)*
16. **What is the end date for this requirement?** *(Month and year, or year.)*
17. **What type of satellite EO data does this requirement pertain to?** *(Mark only one oval.)*

- coarse resolution optical (> 100m)
- medium resolution optical (10-100m)
- fine resolution optical (1-10m)
- very fine resolution optical (<1m)
- hyperspectral data or imagery
- synthetic aperture radar (SAR)
- soundings
- GNSS-RO
- radar altimetry
- imaging multi-spectral radiometers (passive microwave)
- imaging multi-spectral radiometers (vis/IR)
- scatterometry
- magnetometry
- other (add below)

18. **Other satellite EO data type required:** *[Only add if applicable (marked 'other' in the question above).]*

Spatial Resolution

This section is exploring the spatial resolution of the data required. This may be expressed in specific terms, and you are encouraged to provide additional detail as required in the final question of this section.

19. **Please briefly describe the *spatial* resolution required for this satellite EO data.** *(i.e., the scale of a pixel in an image or data product e.g., 10 m for 4 bands in VNIR, 60 m for 3 dedicated atmospheric correction bands, 20 m for remaining bands)*

20. **What is the *threshold* spatial resolution that your data requires?** *(i.e., the threshold for spatial resolution in m, km, or other appropriate units, e.g., 10m, 500m, etc. Mark only one oval.)*

- < 0.5 m
- < 1.0 m
- 1 - 5 m
- 5 - 10 m
- 10 - 30 m
- 30 - 100 m
- 100 - 200 m
- 200 - 500 m
- 500 - 1000 m
- 1 - 2 km
- >2 km
- Other (see description)

21. **What is the *target* spatial resolution that your data requires?** *(i.e., the **target** or **optimal** spatial resolution in m, km, or other appropriate units, e.g., 10m, 500m, etc. Mark only one oval.)*

- < 0.5 m
- < 1.0 m
- 1 - 5 m
- 5 - 10 m
- 10 - 30 m
- 30 - 100 m
- 100 - 200 m
- 200 - 500 m
- 500 - 1000 m
- 1 - 2 km
- >2 km
- Other (see description)

22. If your data's spatial requirement does not fit the threshold and target terminology or you would like to add additional information, please do so here. *(e.g., atmospheric soundings and layers, feature detection, etc.)*

Spectral Resolution

This section is exploring the detail of the spectral information required in the data.

23. Please select the applicable *spectral* resolution(s) required for this satellite EO data.

(i.e., the electromagnetic spectral range for the requirement e.g., typically include the near-infrared (NIR) spectral range of approximately 0.7 to 1.0 micrometres and the shortwave infrared (SWIR) spectral range of approximately 1.5 to 2.0 micrometres e.g., visible and near-infrared. Check all that apply.)

- UV: ~0.01 µm - ~0.40 µm
- VIS: ~0.40 µm - ~0.75 µm
- NIR: ~0.75 µm - ~1.3 µm
- SWIR: ~1.3 µm - ~3.0 µm
- MWIR: ~3.0 µm - ~6.0 µm
- TIR: ~6.0 µm - ~15.0 µm
- FIR: ~15.0 µm - ~0.1 cm
- MW: ~0.1 cm - ~100 cm
- Ka-Band: 26.5 to 40 GHz
- K-Band: 18 to 26.5 GHz
- Ku-Band: 12.5 to 18 GHz
- X-Band: 12.5 - 8 GHz
- C-Band: 8 - 4 GHz
- S-Band: 4 - 2 GHz
- L-Band: 2 - 1 GHz
- P-Band: 0.999 - 0.2998 GHz
- W-Band: 94 GHz
- Other:

24. What is the *threshold* spectral resolution that your data requires? *(i.e., the minimum viable set of spectral responses e.g., visible, x-band SAR e.g., bands in range 0.4 - 0.6 µm)*

25. What is the *target* spectral resolution that your data requires? *(i.e., the target or optimal spectral resolution in terms of bands, wavelengths, or frequency depending on the application e.g., visible, x-band SAR e.g., bands in range 0.4 - 0.6 µm)*

Temporal Resolution and Latency

This section is exploring how often data is required, and the time gap between acquisition and when the data is required.

26. What is the *threshold* temporal resolution that your data requires? *(i.e., how often the application requires data to be collected, e.g., annually, quarterly, monthly, weekly, daily, multiple times a day, on demand, variable, etc. Mark only one oval.)*

- Annually
- Quarterly
- Monthly
- Weekly
- Daily
- Multiple times a day
- < 60 minutes
- < 30 minutes
- < 10 minutes
- < 2 minutes
- On demand
- Variable
- Other (describe below)

27. What is the target temporal resolution that your data requires? *(i.e., ideally how often the application data is collected e.g., annually, quarterly, monthly, weekly, daily, multiple times a day, on demand, variable, etc. Mark only one oval.)*

- Annually
- Quarterly
- Monthly
- Weekly
- Daily
- Multiple times a day
- < 60 minutes
- < 30 minutes
- < 10 minutes
- < 2 minutes
- On demand
- Variable
- Other (describe below)

28. Please add any additional or other comments on *temporal* resolution.

29. What is the *threshold* latency that your data requires? *(i.e., time after acquisition the data needs to be received for processing. Data must be received within _of data capture: Mark only one oval.)*

- < 2 minutes
- < 10 minutes
- < 30 minutes
- < 60 minutes
- < 3 hours
- < 6 hours
- < 12 hours
- 12 hours
- 24 hours
- 1-3 days
- 4-7 days
- 1-2 weeks
- 2-4 weeks
- 1-2 months
- >2 months
- other (see description)

30. What is the *target* latency that your data requires? *(i.e., time after acquisition the data is ideally received for processing. **Ideally**, data would be received within _of data capture: Mark only one oval.)*

- < 2 minutes
- < 10 minutes
- < 30 minutes
- < 60 minutes
- < 3 hours
- < 6 hours
- < 12 hours
- 12 hours
- 24 hours
- 1-3 days
- 4-7 days
- 1-2 weeks
- 2-4 weeks
- 1-2 months
- >2 months
- other (see description)

31. Please add any additional or other comments on latency

Data Access Requirements

This section is exploring any specific data access requirements for your application.

32. **Can you describe any specific data access requirements for your application?** *(e.g., must be available via FTP download, API access required, STAC catalogue, etc.)*

33. **Can you describe any specific data format requirements for your application?** *(e.g., must be in NetCDF format, GeoTIFF only, COG, unsure, to be determined)*

34. **Would you like to add another data requirement? *** *(Mark only one oval.)*

    - Yes *Skip to question 35*
    - No Skip to question 122

Note: Questions 13 to 33 are repeated for each satellite EO data requirement, to a maximum of 5. For more than 5 satellite EO data requirements, the respondent is requested to submit this response and start a new response adding more requirements.

35. **Point of Contact (name, email) (optional)**

Risks to Continuity of EO Data Supply for Australia: Satellite EO Data Use Interview Questions

Questions:

1. Are there any comments/questions from the pre-interview survey and data usage/project sheet?
2. What is the minimum data supply to meet your needs i.e., is there a single source you could use, or do you need all of the EO data sources you currently access?
3. Do you think this will change over the next 12-24 months?
4. What EO data do you anticipate you will need in the future, but don't currently have access to?
5. Are there any new EO data sources that you plan to use over the next 12-24 months?
6. What do you think of free and open data?
7. Do you already use, or would you use analysis ready data?
8. Would you use analysis ready data if it was instrument-agnostic data if it provided the specifications required? i.e., a product created from multiple EO data sources
9. Is tasking capability to capture EO satellite data important? How difficult do you find this process?
10. Is calibration of EO data important to you? How do you carry out calibration currently?
11. Is validation of EO data important to you? How do you carry out validation currently?
12. Are there any international partners/stakeholders you work with and which projects?
13. Are there any national partners/stakeholders to this application you work with and which projects?
14. Are licence limitations an issue when accessing and using satellite imagery?
15. Is cost versus open data an issue? What do you think of free and open data?
16. Are your projects mostly operational applications or a research application?

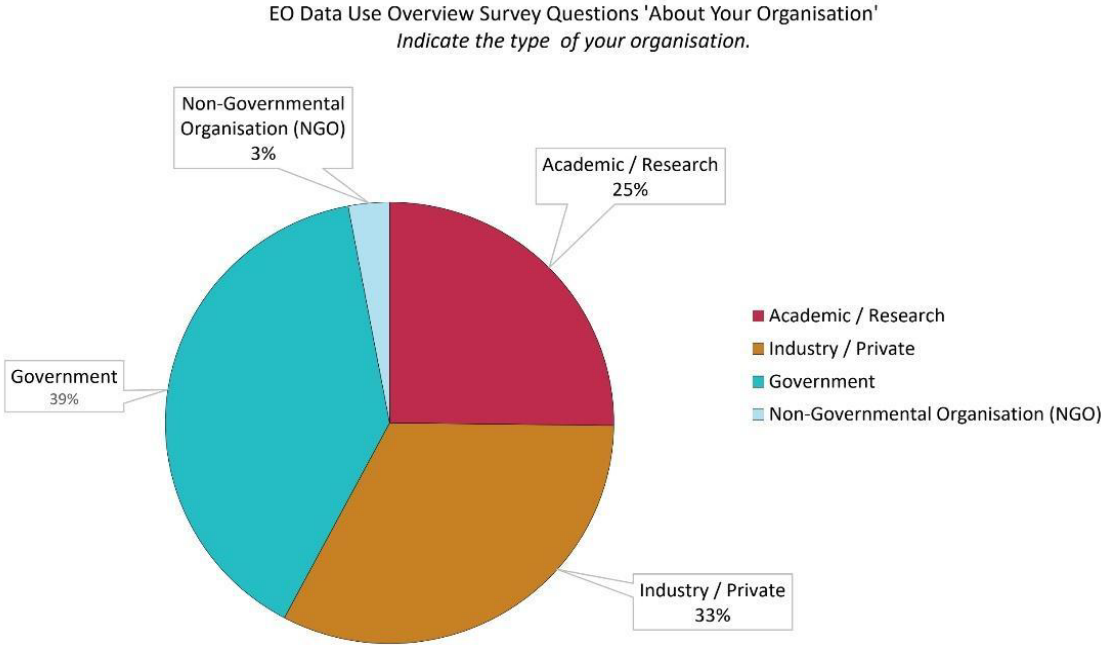
17. Is this a public good service?
18. Are your projects for an internal or external audience?
19. What are the risks or issues you see to EO data supply?

Due to time constraints only questions relevant to the interviewee were asked during the interview.

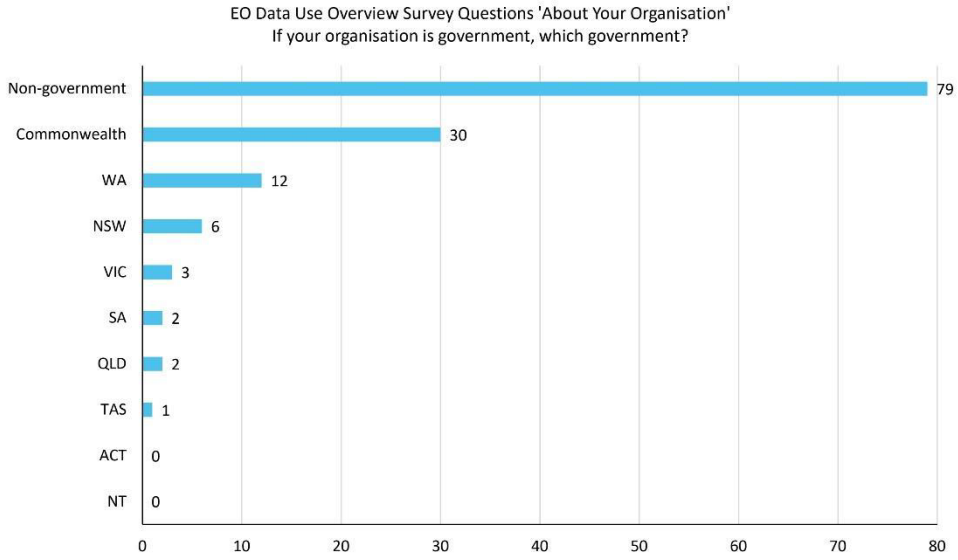
Appendix E: Analysis of Survey Responses

Total: 135 survey responses were received.

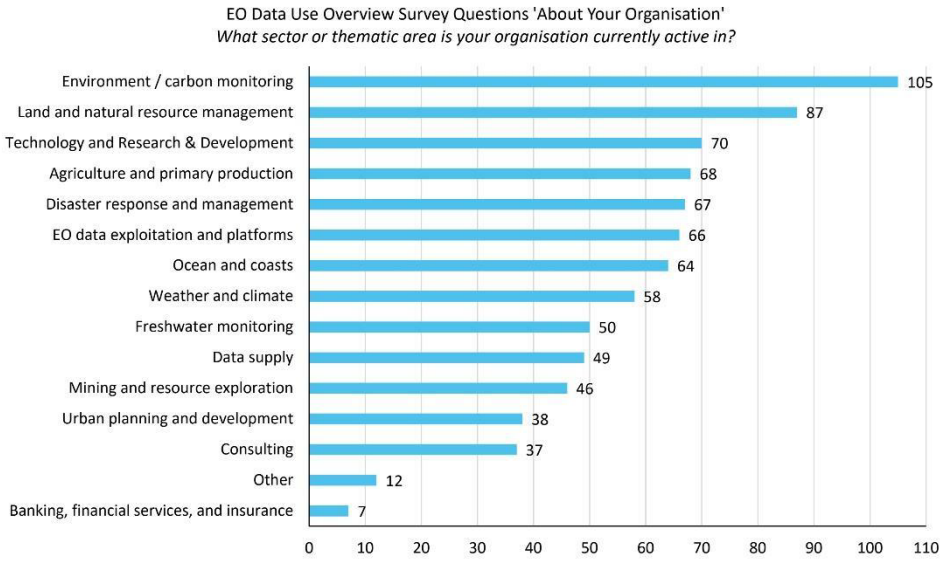
Organisation Type	Count
Academic / Research	34
Industry / Private	44
Government	53
Non-Governmental Organisation (NGO)	4



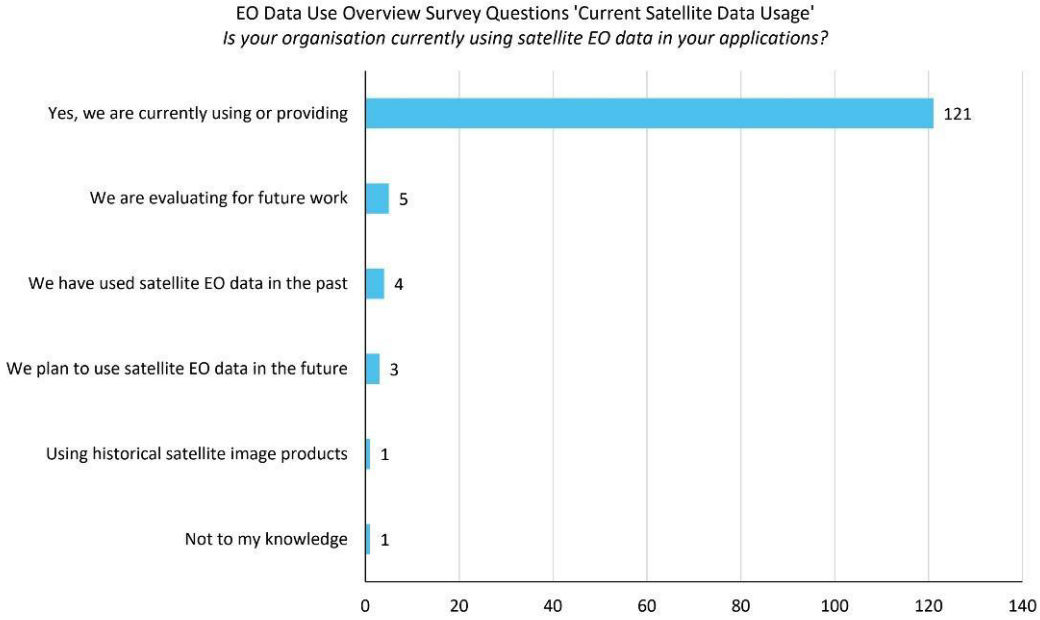
Government Type	Count
NT	0
ACT	0
TAS	1
QLD	2
SA	2
VIC	3
NSW	6
WA	12
Commonwealth	30
Non-government	79



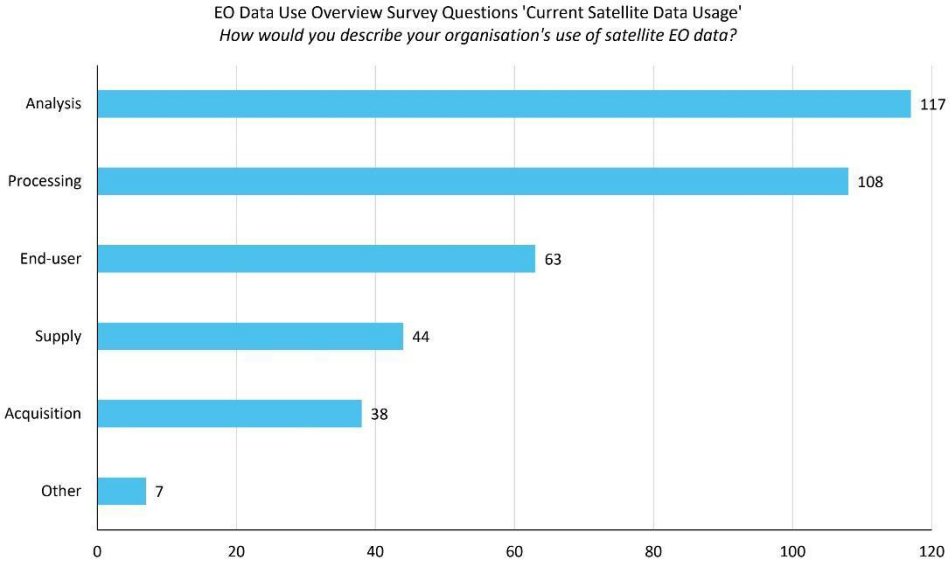
Sector	Count
Banking, financial services, and insurance	7
Other	12
Consulting	37
Urban planning and development	38
Mining and resource exploration	46
Data supply	49
Freshwater monitoring	50
Weather and climate	58
Ocean and coasts	64
EO data exploitation and platforms	66
Disaster response and management	67
Agriculture and primary production	68
Technology and Research and Development	70
Land and natural resource management	87
Environment / carbon monitoring	105



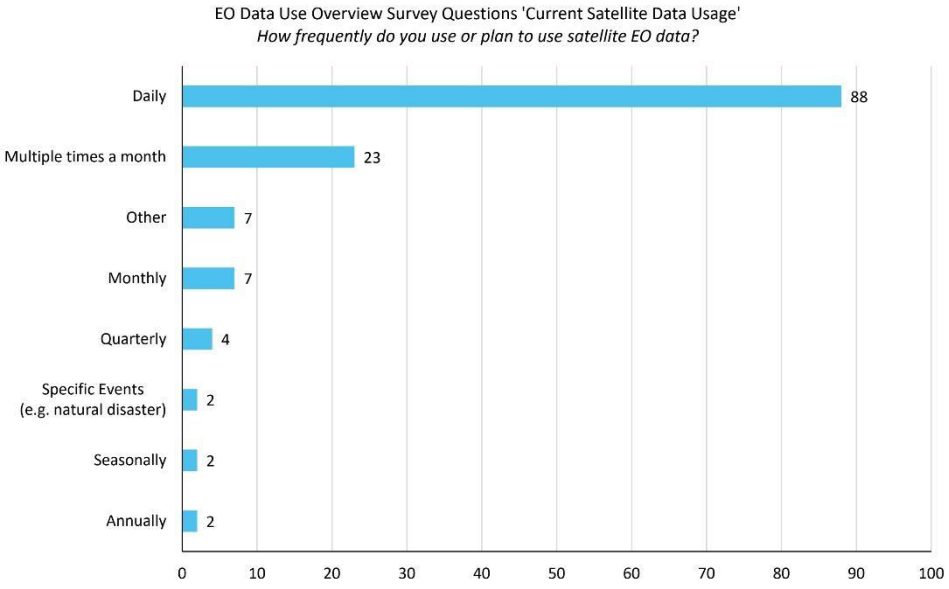
Is your organisation currently using satellite EO data in your applications?	Count
Not to my knowledge	1
Using historical satellite image products	1
We plan to use satellite EO data in the future	3
We have used satellite EO data in the past	4
We are evaluating the use of satellite EO data for future work	5
Yes, we are currently using or providing satellite EO data	121



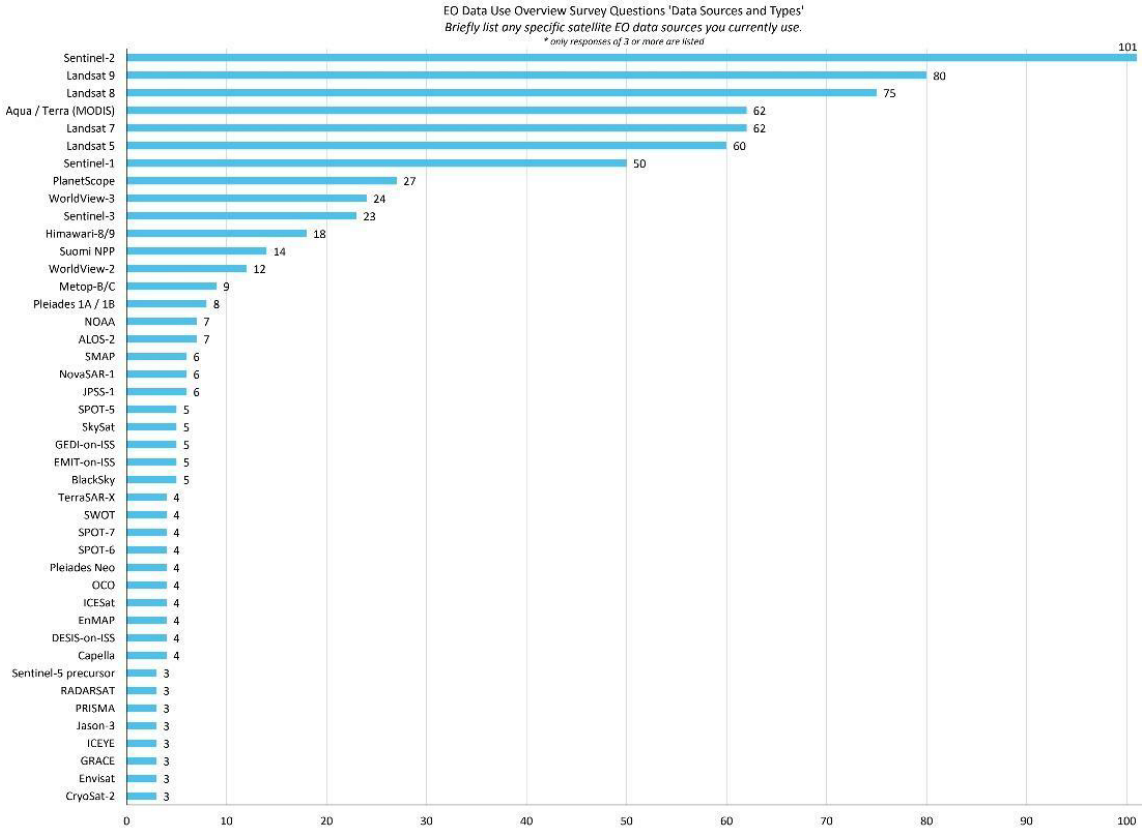
How would you describe your organisation's use of satellite EO data?	Count
Other	7
Acquisition	38
Supply	44
End-user	63
Processing	108
Analysis	117



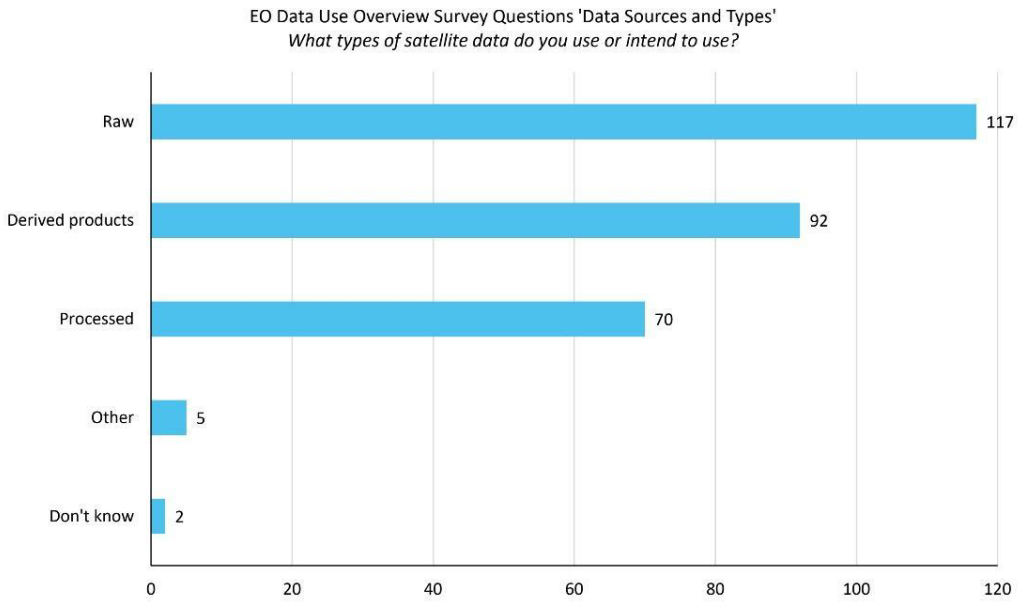
How frequently do you use or plan to use satellite EO data?	Count
Annually	2
Seasonally	2
Specific Events (e.g., natural disaster)	2
Quarterly	4
Monthly	7
Other	7
Multiple times a month	23
Daily	88



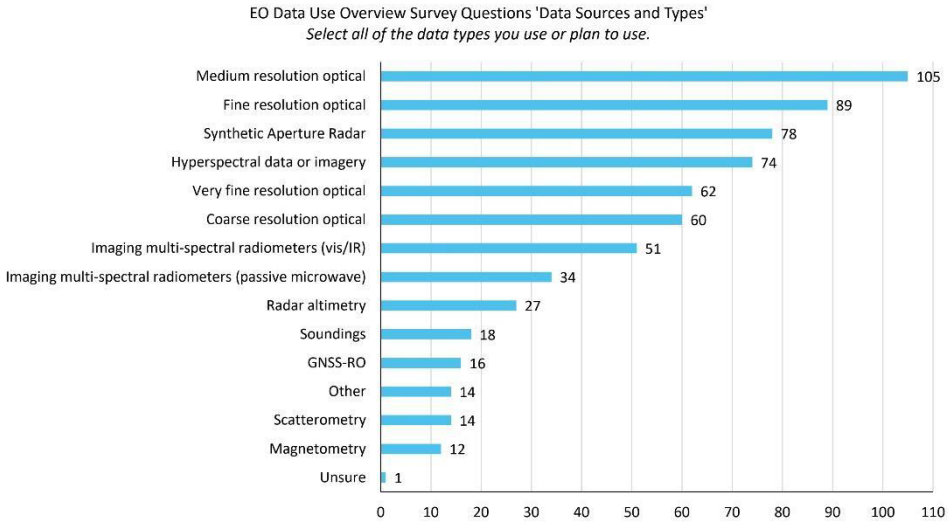
Briefly list any specific satellite EO data sources you currently use.	Count
CryoSat-2	3
Envisat	3
GRACE	3
ICEYE	3
Jason-3	3
PRISMA	3
RADARSAT	3
Sentinel-5 precursor	3
Capella	4
DESIS-on-ISS	4
EnMAP	4
ICESat	4
OCO	4
Pleiades Neo	4
SPOT-6	4
SPOT-7	4
SWOT	4
TerraSAR-X	4
BlackSky	5
EMIT-on-ISS	5
GEDI-on-ISS	5
SkySat	5
SPOT-5	5
JPSS-1	6
NovaSAR-1	6
SMAP	6
ALOS-2	7
NOAA	7
Pleiades 1A / 1B	8
Metop-B/C	9
WorldView-2	12
Suomi NPP	14
Himawari-8/9	18
Sentinel-3	23
WorldView-3	24
PlanetScope	27
Sentinel-1	50
Landsat 5	60
Landsat 7	62
Aqua / Terra (MODIS)	62
Landsat 8	75
Landsat 9	80
Sentinel-2	101


EO Data Use Overview Survey Questions 'Data Sources and Types'
Briefly list any specific satellite EO data sources you currently use.
* only responses of 3 or more are listed
Sentinel-2 101
Landsat 9 80
Landsat 8 75
Aqua / Terra (MODIS) 62
Landsat 7 62
Landsat 5 60
Sentinel-1 50
PlanetScope 27
WorldView-3 24
Sentinel-3 23
Himawari-8/9 18
Suomi NPP 14
WorldView-2 12
Metop-B/C 9
Pleiades 1A / 1B 8
NOAA 7
ALOS-2 7
SMAP 6
NovaSAR-1 6
JPSS-1 6
SPOT-5 5
SkySat 5
GEDI-on-ISS 5
EMIT-on-ISS 5
BlackSky 5
TerraSAR-X 4
SWOT 4
SPOT-7 4
SPOT-6 4
Pleiades Neo 4
OCO 4
ICESat 4
EnMAP 4
DESIS-on-ISS 4
Capella 4
Sentinel-5 precursor 3
RADARSAT 3
PRISMA 3
Jason-3 3
ICEYE 3
GRACE 3
Envisat 3
CryoSat-2 3
0 10 20 30 40 50 60 70 80 90 100

What types of satellite data do you use or intend to use?	Count
Don't know	2
Other	5
Processed	70
Derived products	92
Raw	117



Select all of the data types you use or plan to use.	Count
Unsure	1
Magnetometry	12
Scatterometry	14
Other	14
GNSS-RO	16
Soundings	18
Radar altimetry	27
Imaging multi-spectral radiometers (passive microwave)	34
Imaging multi-spectral radiometers (vis/IR)	51
Coarse resolution optical	60
Very fine resolution optical	62
Hyperspectral data or imagery	74
Synthetic Aperture Radar	78
Fine resolution optical	89
Medium resolution optical	105



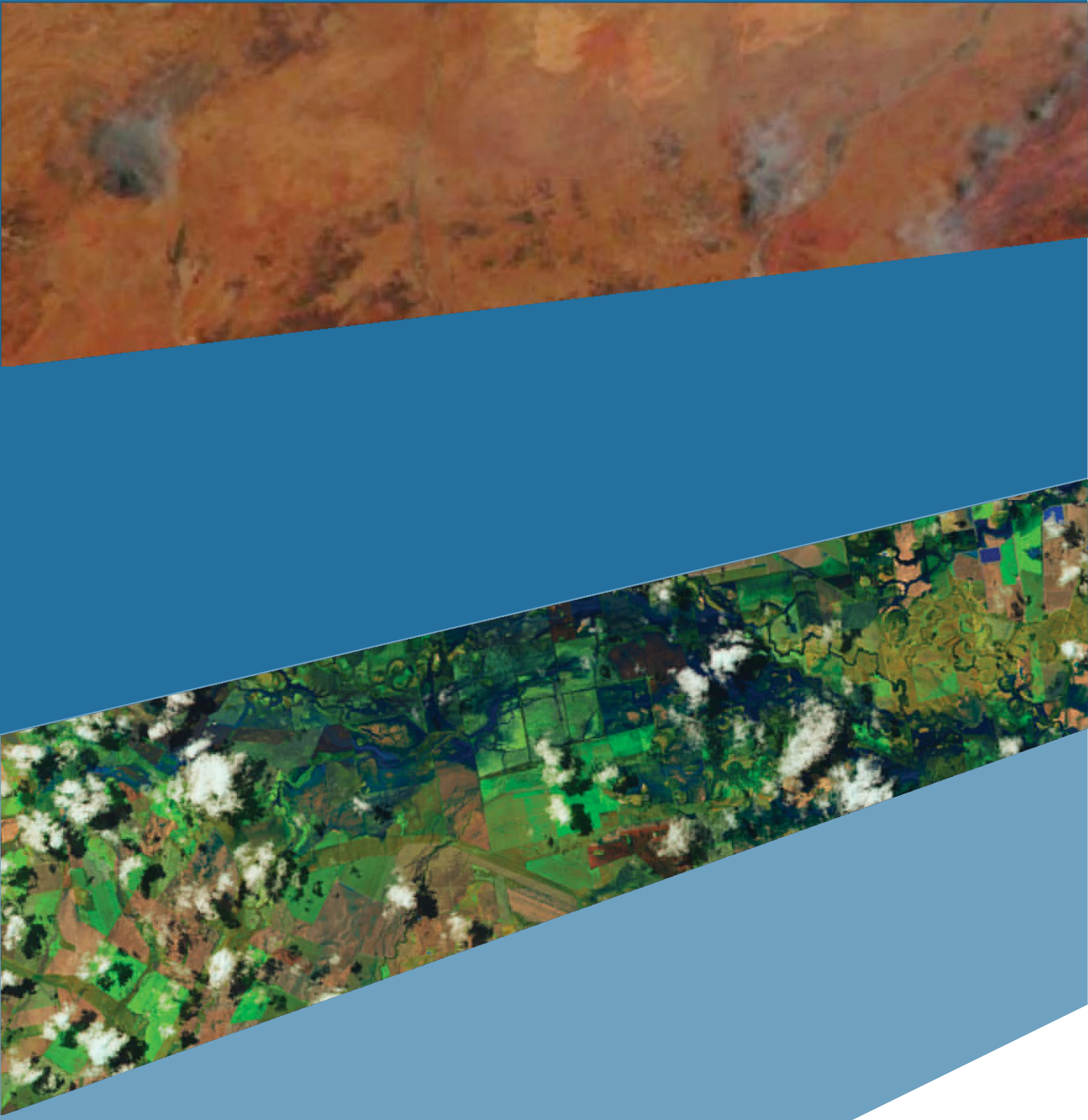
Appendix F: Full risk evaluation table

	Consequence				
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe
Almost certain	NA	NA	PR10: Key EO missions reach end of life and are not replaced with new operational missions T3: Inability to independently verify satellite EO data provenance including data spoofing and tampering	PO1: Foreign government open/free data or distribution policy change PO2: Foreign government acquisition strategy change PO4: Change in foreign government partner policy ambition/ability to provide world-leading satellite EO systems for operational or scientific needs PO6: Lack of binding data supply agreements with key providers leads to sudden demise of supply PO9: Changes in foreign policy or data availability arising from the increase in regional/international geopolitical conflict and tension PR8: Inability or delayed ability to respond to future data supply risks	NA

	Consequence				
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe
Likely	NA	M1: Potential disruptions or fluctuations in the availability or cost of a product due to changes in overall market conditions or market failures T5: Insufficient or inconsistent calibration data or approaches	PO11: Australia prioritises foreign partnerships in EO based on national security or defence needs, instead of civilian needs M6: Obsolete or discontinued software and/or platforms PR3: Loss of access to or significant delays in access to launch PR5: Sustaining Australian university capacity and support PR7: Australia's talent pool is insufficient to meet demand T4: Inadequate training data to drive future AI uptake in Australia and/or other collaborating countries	PR6: Australian Government program funding changes impact future key programs and infrastructure	NA

	Consequence				
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe
Possible	NA	PR11: Operational use of and dependence on research missions E5: Terrestrial frequency interference T1: Failure or degradation of onboard systems leads to degraded or lost capability T2: Ground segment systems failure T6: Inconsistent processing of Analysis Ready and derived data products	PO8: Australia or strategic partners' access to satellite launchers is restricted for strategic, geopolitical, or tactical reasons PO10: Australian Government policy restricts use of EO data sources from foreign governments and companies M2: Commercial market demand for on demand acquisition services saturates capacity M3: Changes to international free and open data policy reduce or impeded commercial viability of EO products and services PR1: Reliance on International Partners to select, develop, fund and operate missions that correspond to Australian needs PR4: Foreign government priorities change, shifting space agency activities	PO3: Foreign government exercise shutter or export controls for strategic, market or tactical reasons PO5: Poor Australian burden-sharing leads to data providers not willing to provide free data to Australia PO7: Change to WMO data policy or country participation M5: Globalisation means domestic Australian EO data service providers become too expensive PR9: Foreign government EO program designed to shift global power allegiance	NA

	Consequence				
Likelihood	Insignificant	Minimal	Moderate	Substantial	Severe
Unlikely	NA	NA	E1: Space debris collision destroys satellite E4: Communication uplink/downlink disrupted	E2: Collision or series of collisions of other spacecraft degrade orbital environment or render it unusable and impact satellite performance and reliability	
Rare	NA	PR2: Loss of key missions due to launch failure	NA	M4: Significant downturn in the Australian economy means foreign commercial data too expensive for users E3: Solar flare impacts spacecraft performance, lifetime or context	NA



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AUSTRALIA

Symbios

EOA Earth Observation Australia Inc