SMARTSAT
COOPERATIVE RESEARCH CENTRE

MARKET STUDY

UNLOCKING QUEENSLAND'S POTENTIAL THROUGH EARTH OBSERVATION

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MARKET STUDY RESULTS & STRATEGIC RECOMMENDATIONS FOR THE QUEENSLAND EARTH OBSERVATION HUB

August 2023

SMARTSAT COOPERATIVE RESEARCH CENTRE

Australian Government
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EXECUTIVE SUMMARY

Purpose

This report presents the results of a market study of Queensland's Earth Observation (EO) community run between May and July 2023. This market study was performed through a background literature review, an online survey, direct interviews, and workshops incorporating a range stakeholders' representative of key sectors in Queensland and along the Earth Observation value chain.

Through this market study, the opportunities, and gaps, both presently and over the coming five years, have been critically explored. This document presents the outcomes of this market study, with the intent of providing the current state and future opportunities perspective that emerge from these results and informing a path forward for the Queensland Earth Observation Hub in the future.

Opportunities

Broadly, the biggest opportunities reported in the next 2-5 years were:

- Collaboration and alignment between research, industry, and government. This includes improving communication to increase awareness of needs and capabilities and promoting the transfer of skills and knowledge.
- Commercialisation of research. This includes facilitating research-industry partnerships to provide pathways for industry uptake of research outcomes.
- Building capacity in Queensland to cater to national and international markets, by promoting Queensland's capabilities, connecting industry to these markets, and attracting investment.
- Workforce development, by facilitating access to new and in demand skills, knowledge transfer, and promoting EO careers.

Gaps and Challenges

The biggest gaps and challenges in the next 2-5 years were reported as being:

- Access to fit for purpose EO data, incorporating issues of resolution, cadence, costs and reliability.
- Access to fit for purpose data sharing infrastructure including licencing and agreement on standards that promote data harmonisation and interoperability.
- Certainty of financial sustainability, including continued R&D funding, attracting investment, and improving participation in government EO initiatives.
- Improved understanding across the EO industry of the needs and drivers of different sectors for growth.
- Improved visibility of the EO industry to potential end users and the broader public.
- The development of, and access to, a skilled workforce.

Key Strengths

Key Strengths of the Queensland EO Industry are:

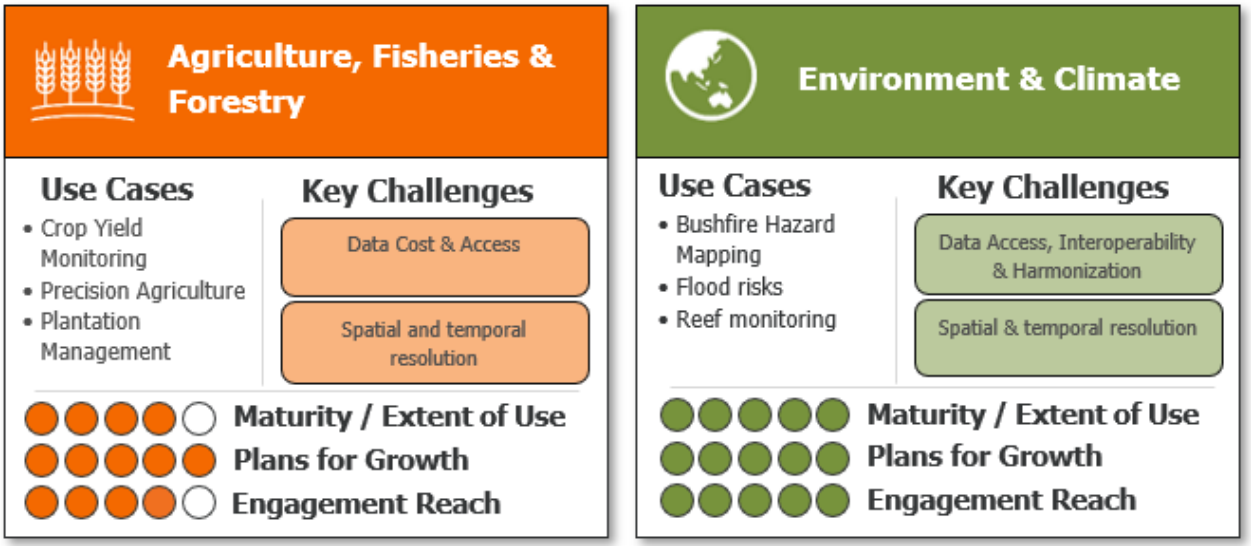
- It provides a vast opportunity due to a diverse geography, use cases and industry needs.
- Queensland Government's strategy in supporting the EO industry through the Queensland EO Hub, and Queensland Government's investment in significant EO data acquisition programs such as the Spatial Imagery Services Program (SISP).
- Queensland universities and institutions providing leading EO research and teaching capabilities.
- Queensland is primed for growth through these strengths, opportunities, and a willingness to address the gaps and challenges.

Opportunities and Challenges

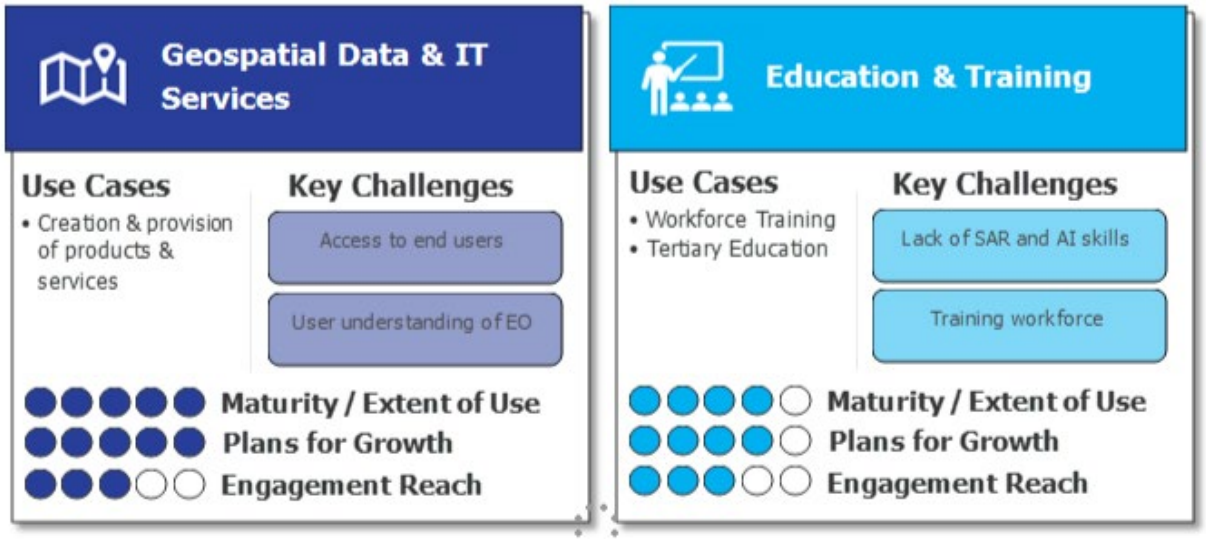
Partnerships and Collaboration	Education and Capacity Development	Data Access	Data Processing, Interoperability and Harmonisation	Sustainability, Strategy and Policy
• Fragmentation of EO Community – requiring coordination • Increase engagement and communication between industry and end users • National and International partnerships and collaboration	• Consultation between academia and industry on skills and needs • Capacity development and staff retention • Skills gaps – emerging platforms and methodologies, multi-disciplinary approach, understanding potential for EO • Promotion of EO and Geospatial careers	• Data Sharing, Accessibility and dissemination • Data Affordability for High Resolution Imagery • Facilitate flexible data licensing arrangements • Increase sovereign data sources.	• Data processing • Data Interoperability • Data Fusion	• Developing effective strategies and policy

Sector Analysis

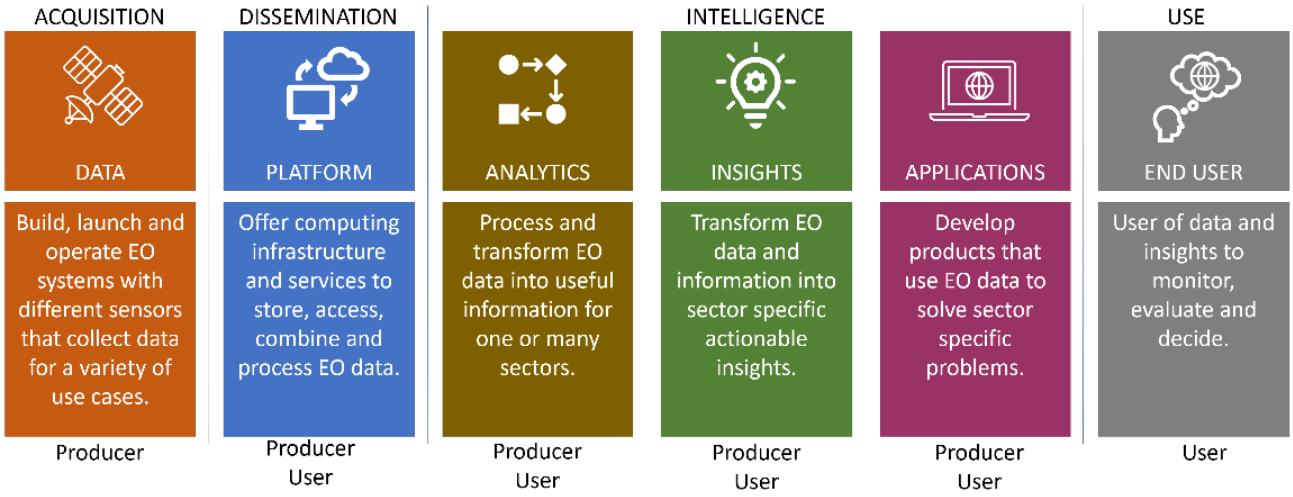
The sector analysis revealed that most highlighted opportunities and challenges were relevant and applicable for each sector consulted. The key sector-based findings are summarised below.




Infrastructure, Planning & Construction
Use Cases
• Site monitoring
• Transport management
• Digital Twin visualisation
Key Challenges
Data Access, Interoperability & Harmonization
Sector awareness of EO's role
Maturity / Extent of Use
Plans for Growth
Engagement Reach
Utilities and Telecommunications
Use Cases
• Asset management
• Project visualisation
• Service monitoring
Key Challenges
Data Access, Interoperability & Harmonization
Visibility of stakeholders across EO
Maturity / Extent of Use
Plans for Growth
Engagement Reach
Banking, Finance & Insurance
Use Cases
• Environmental risks
• Understanding of socio-economic data
Key Challenges
Exploiting growing data
Fusing EO, spatial and socio-economic data
Maturity / Extent of Use
Plans for Growth
Engagement Reach
Mining & Energy Resources
Use Cases
• Mineral Prospecting
• Environmental Impact
• Mine closure
• ESG
Key Challenges
Access to new sensors/data (e.g., hyperspectral)
Standardisation and aggregation
Maturity / Extent of Use
Plans for Growth
Engagement Reach
Health, Public Safety & Emergency Management
Use Cases
• Disaster mitigation & response
• Bushfire Planning & Response
• Health quality measures
Key Challenges
Data frequency & latency, Access to new sensors
Data Access, Interoperability & Harmonization
Maturity / Extent of Use
Plans for Growth
Engagement Reach
Defence, Security & Aerospace
Use Cases
• Border protection
• Threat monitoring
• International aid
Key Challenges
Reliance on foreign data
Data Procurement
Maturity / Extent of Use
Plans for Growth
Engagement Reach



Value Chain Analysis



Participants responded that their use of EO forms a component across most of the value chain, with a reasonably even distribution of use across each value chain segment. The most projected future use of EO across the value chain has been reported to likely occur in data acquisition and platform infrastructure and data dissemination are predicted be the most developing part of the value chain across all sectors, however growth is expected across the whole value chain with >95% participants reporting expectations of some growth

Priorities for Queensland Earth Observation

Based on the market analysis, the following activities have been identified as priorities for the Queensland Earth Observation Community:

- Promote open data policies, encourage data accessibility and adopt the FAIR principles.
- Understand workforce needs, invest in education and training programs, collaborate with universities and research institutions.
- Support initiatives for SMEs to grow in the EO industry.

- Facilitate partnerships between the EO industry and academia and develop collaborative research projects.
- Raise awareness about the importance of EO and its applications across sectors like agriculture, environmental monitoring, disaster management, urban planning, etc.
- Engage nationally, with other states and internationally to share knowledge, expertise, and data.
- Develop supportive policies and regulations that encourage the growth of the EO sector while supporting ethics and privacy standards.
- Explore and support commercial applications of EO data, such as in the agriculture, mining, forestry, and tourism industries.
- Highlight successful case studies, including products and projects, that have utilized EO data to bring about positive impacts in various fields.
- Encourage the government and private sector to invest in satellite technology, and essential infrastructure.

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ACKNOWLEDGEMENTS

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TABLE OF ACRONYMS

ACRONYM	DEFINITION
ASA	Australian Space Agency
ASST	Australian Space Skills Taxonomy
ATC	Air Traffic Control
Cal/Val	Calibration and Validation
CARD4L	CEOS Analysis Ready Data for Land
CEOS	Committee of Earth Observation Satellites
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFAT	Department of Foreign Affairs and Trade
DSDILGP	Department of State Development, Infrastructure, Local Government and Planning
ENSO	El Niño–Southern Oscillation
EO	Earth Observation
EOA	Earth Observation Australia
EO Hub	Queensland Earth Observation Hub
ESA	European Space Agency
FAIR	Findable, Accessible, Interoperable and Reusable
GPS	Global Positioning System
IP	Intellectual Property
JRSRP	Joint Remote Sensing Research Program
LiDAR	Light Detection and Ranging
NASA	National Aeronautics and Space Administration
R&D	Research and Development
SAR	Synthetic Aperture Radar
SWOT	Strengths, Weaknesses, Opportunities & Threats
QLD	Queensland
UQ	University of Queensland

LIST OF FIGURES

1. INTRODUCTION

1.1. Background

The Queensland Earth Observation Hub (EO Hub), established in mid-2022, incorporates the SmartSat Queensland Node and is a jointly funded initiative of SmartSat CRC and the Queensland Government's Department of State Development, Infrastructure, Local Government and Planning (DSDILGP)

The EO Hub was established to accelerate the growth of Queensland's Earth observation industry by supporting commercialisation of research, and product and service development. The EO Hub will generate opportunities for data analytics businesses and researchers, as well as downstream industries and upstream service providers of Earth imagery.

The EO Hub aims to build effective and sustainable research and commercial collaborations between research organisations and Earth observation-related business through:

- facilitating access to the research expertise and intellectual property needed to develop new product and service opportunities via new and existing product development projects.
- supporting the exchange of specialist expertise, skills, and business acumen via a mobility and training scheme; and
- enabling access to research technology infrastructure, including data platforms.

1.2. Purpose of the Document

To achieve the EO Hub's goals it is important to understand the opportunities and gaps in the EO sector, both currently and in the coming 5 years.

To help inform these initiatives, this report presents the results of a market study of Queensland's Earth Observation community run between May and July 2023. This market study has undertaken surveys, interviews, and workshops across a range of sectors in Queensland, and along the Earth Observation value chain in Queensland, across industry, research, and government. Through this, the opportunities, and gaps both presently and over the coming five years have been critically explored with this audience. This document presents the outcomes of this market study, with the intent of providing the current state and future opportunities perspective that emerge from these results and informing a path forward for the Queensland Earth Observation Hub in the future.

2. LANDSCAPE ANALYSIS OF EARTH OBSERVATION IN QUEENSLAND

Queensland, Australia, encompasses diverse landscapes, ranging from the Great Barrier Reef to vast outback regions, over large geographical areas. Geospatial technology and Earth Observation play crucial roles in managing and understanding this diverse environment, and plays a critical role in various sectors, including urban planning, mining, energy, natural resource management, agriculture, disaster response, and environmental monitoring.

2.1 Queensland's Space Industry

The space industry is a priority industry for the Queensland Government. The Queensland Government's objectives and activities to grow the Queensland space industry are set out in the Queensland Space Industry Strategy

(Queensland Space Industry Strategy 2020-2025). Queensland's space industry is projected to directly create as many as 6000 high-value jobs in Queensland and contribute $3.5 billion to $6 billion to the State economy by 2036.). Furthermore, introducing, and utilising space products in other industries to improve productivity, such as agriculture and mining, has been projected to contribute $1.1. billion to $1.7 billion in productivity by 2036. This aligns with the Australian Space Agency's (ASA) target to triple the size of Australia's space economy to $12 billion per annum from the current $3-4 billion and create an additional 20,000 jobs on top of the existing 10,000 jobs by 2030. Earth Observation is identified in the Queensland Space Industry Strategy as a key strength for Queensland, and a critical pathway for deriving social, environmental, and economic value from the space industry for government, industry and the community.

2.2 Queensland's EO Community

The EO community in Queensland is active, with many local, national and international actors undertaking research, developing products and services, and gaining insights from EO data to support and enable operational decision making across Queensland's key sectors including agriculture, mining and environment. This community is also growing, driven by advancements in sensor technologies, analytics and AI capabilities, and the increasing understanding in the value of EO. However, there are still more opportunities to be realised which will result in increased economic return from the adoption and implementation of EO technology across Queensland, Australia and internationally.

Industry uptake of EO in Queensland is significant, with 88 individual companies identified as direct stakeholders during the short period of the market analysis and many more to be identified. Company types ranged from small startups creating insights from EO data, to large multinational corporations deriving value and decision support from data and data insights. These companies are active across all market sectors (see section 3.1) and all downstream activities in the EO value chain (see section 3.2).

Government is a large stakeholder in the Queensland EO community. Federal government initiatives such as Digital Earth Australia provides data and infrastructure for EO analysis and insights. Queensland Government runs multiple initiatives including the Spatial Imagery Services Program (SISP) that supports the capture imagery from a range of remote platforms to be accessed by government departments, local government and industry. Local governments engaged in the market analysis have plans for using EO for environment and urban management purposes.

Presently, in Queensland EO is widely used for research purposes, however there is a significant opportunity to improve the flow-through from research to government and industry. To ensure long-term economic return, EO needs to translate more commercial use cases. To do so, it is necessary to ensure there is adequate workforce training to ensure long term supply of staff to be able to utilise EO for cutting edge technology. (Phinn, Scarth, Michael, & Edkins, 2020). Such actions will require strong collaboration and facilitated interactions between research and industry, and greater awareness of market ready research qualities (Phinn, Scarth, Michael, & Edkins, 2020).

Queensland has excellent teaching and research capability for EO, however further development of these programs would be beneficial to increase the training and capacity development for the EO sector. This in turn would greatly contribute to the increased uptake of EO products and services in industry. Many roles in the Australian space sector are at risk of shortages currently or in the future primarily due to lack of training available, not currently present extensively as jobs throughout the industry or high demand with little supply. (SmartSat CRC, 2021). It has been identified that all 319 tier three space related skills in the Australian Space Skills Taxonomy (ASST) exist in the Australian space sector, however, there is a shortage of all these skills. (SmartSat CRC, 2021).

2.3 Queensland's EO Technical Foundations

Queensland has well-established geospatial infrastructures and capabilities that include geospatial data repositories, spatial data infrastructures, and mapping agencies. Multiple Queensland Government agencies, including the Departments of Resources; Transport and Main Roads; and Environment and Science, and other government, research and private industry organizations actively develop maintain and distribute geospatial datasets and infrastructure, including, but not limited to geodetic networks, imagery repositories, open data platforms and satellite ground stations. These datasets and facilities enable accurate positioning, data collection, and storage for various applications.

Remote sensing technologies, (hereafter referred to as Earth Observation (EO)), such as satellite, drone, aerial photography, and LiDAR (Light Detection and Ranging) sensors, are extensively utilised in Queensland. These technologies enable the collection of Earth Observation data and information, which is then leveraged by government agencies, research institutions, and private enterprises to support a large and increasing number activities including environmental monitoring and land management.

Queensland benefits from a range of international satellite missions that provide O data. Satellites, such as those operated by the European Space Agency (ESA) such as Sentinel-2, and the National Aeronautics and Space Administration (NASA) such as Landsat and MODIS, capture imagery at regular intervals as part of their background operational missions, thus providing reliable and timely access to a continued feed of data, which in turn enables widespread monitoring of land surface processes and the opportunity to exploit these data to a wide array of application areas.

Additionally, GIS technology is widely used in Queensland as a complementary tool for spatial analysis, mapping, and decision support. Various government agencies, local councils, and private organizations utilize GIS to manage and visualize spatial data effectively. Queensland government provides access to several GIS platforms and datasets for public use.

3. MARKET STUDY APPROACH: SECTORS AND EARTH OBSERVATION VALUE CHAIN

For the purpose of this market study, we have evaluated the EO market in Queensland via two distinct lenses; the first, segmented by market sector, the second, segmented by value chain.

3.1 Industry Sectors

The first lens, through which the findings have been assessed is by priority industry sectors, identified through a collaborative process with SmartSat CRC, DSDILGP, and informed by a literature review (Figure 1).

Figure 1 - Overview of Earth Observation Market Sectors

3.2 Earth Observation Value Chain

The Earth Observation value chain (Buczkowski, 2023) is a tool which has been used globally to conceptualise the upstream, midstream and downstream ways that EO data can be captured, handled and exploited. For the purposes of this study, the focus remained on the downstream value chain, from dissemination to use, as outlined in Figure 2.

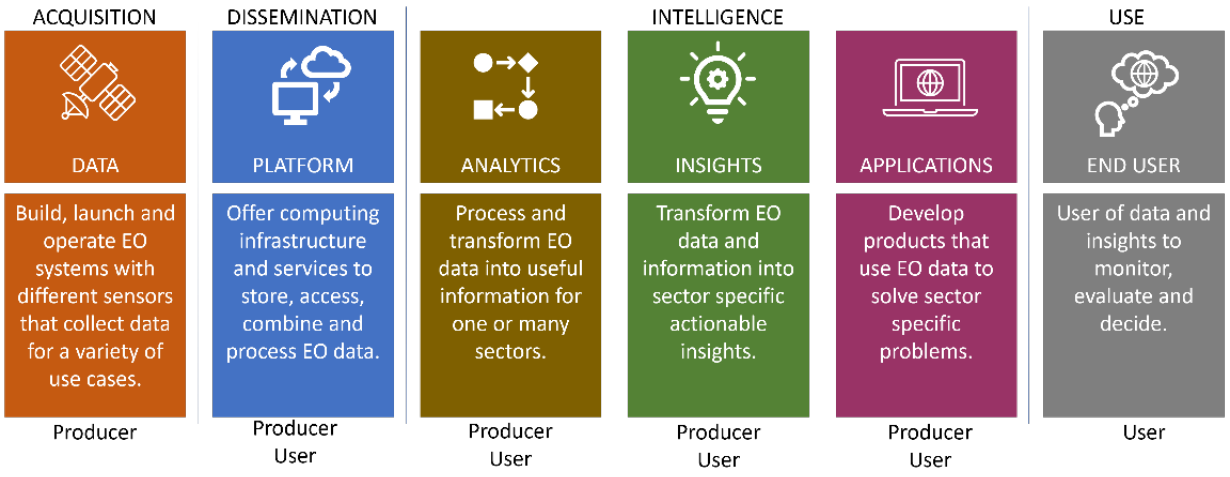


Figure 2 - Overview of the downstream Earth Observation Value Chain

4. MARKET SEGMENTATION & ENGAGEMENT

4.1 Methodology

This market study incorporated multiple qualitative research techniques, including stakeholder mapping, surveys, targeted in-depth interviews, validation of preliminary findings via a workshop (in-person and online), and a desk-based literature review.

Figure 3 - Stakeholder Engagement Approach

4.1.1. Stakeholder mapping

The first phase of this work consisted of stakeholder mapping. This was undertaken through a combination of desktop research, engaging with members of the EO community, and drawing on the expertise of the authors.

An initial stakeholder list was developed and segmented based on engagement methods (survey, interviews, workshop). Engagement was established from this list, and evolved due to social media engagement and promotion, promotion in newsletters, word of mouth, etc. The participants responses were collated and analysed anonymously, to allow for an open discussion.

4.1.2 Survey

An online survey was undertaken to engage with audiences broadly across Queensland and consisted of a combination of multiple-choice and open response questions.

The survey was directly shared with members of the stakeholder list compiled during the initial phase of this research. In addition, the survey was distributed via several social media channels, including LinkedIn and Twitter. The survey was further distributed directly to organisations where a named contact was not available.

The survey was completed by 59 people in the time it was open, from June 21 – July 19, 2023. Of these responses, 18 were only partially completed (potentially due to time constraints), and insights from these responses were utilised where possible. For the list of survey questions see Appendix I – Engagement Details.

4.1.3 Interviews

To further deepen our understanding of the EO Market and Community in Queensland, we undertook qualitative research in the form of targeted interviews with key members of the QLD EO community. These interviews were all delivered online, averaging 40 minutes in duration, and the participants identity has been protected to ensure their anonymity. The interview process took each participant through a series of predefined questions, with the goal to understand from individuals across the downstream EO value chain, and across various sectors (in industry, government, and research). For the list of interview questions see Appendix I – Engagement Details.

A total of 24 interviews were conducted. Each online interview was recorded, digitally transcribed using Otter.ai, and manually proofread for accuracy. These corrected transcripts were then coded using a qualitative coding research tool, Delve.

Qualitative coding is a method for the systematic categorization of excerpts in qualitative data, with the objective to identify common themes and patterns, and the approach enables further analysis of these themes and patterns. Coding qualitative data makes the analysis more systematic and rigorous, whilst providing transparency and

reflexivity. This market study adopted several types of qualitative coding; Inductive, Deductive, and In Vivo. An overview of these and the qualitative codes used is available in Appendix II – Qualitative Coding Methodology.

4.1.4 Workshop

Two workshops were held on Wednesday, July 19, 2023, in Brisbane. The first of these workshops was held face-to-face in Brisbane CBD, and the second held online to those who were not able to attend the first workshop due to geography or other commitments. The purpose of these workshops was to:

- Present and discuss preliminary findings from survey and interview industry engagement
- Gain a deeper understanding of what participants feel the Queensland EO sector can achieve and what opportunities there are to help create the best future for it
- Support the Queensland EO sector coming together to build community

A total of 24 participants attended the face-to-face workshop, and 3 participants attended the virtual workshop. For an overview of the workshop structure see Appendix I – Engagement Details.

4.2. Engagement Overview

In summary, we engaged with **59 stakeholders across 50 organisations via the survey, 24 stakeholders took part in in-depth interviews, and 27 stakeholders attended the validation workshops**.

Overall, we have the most sector engagement (noting that all participants self-identified as operating from one or more sectors) from Agriculture, Fisheries and Forestry (31 participants), Environment and Climate (44 participants) and Geospatial data and IT Services (40 participants) (Figure 4, Figure 5). We had the least engagement with Defence, Security and Aerospace (12 participants) and the Banking, Finance, and Insurance Sector (11 participants).

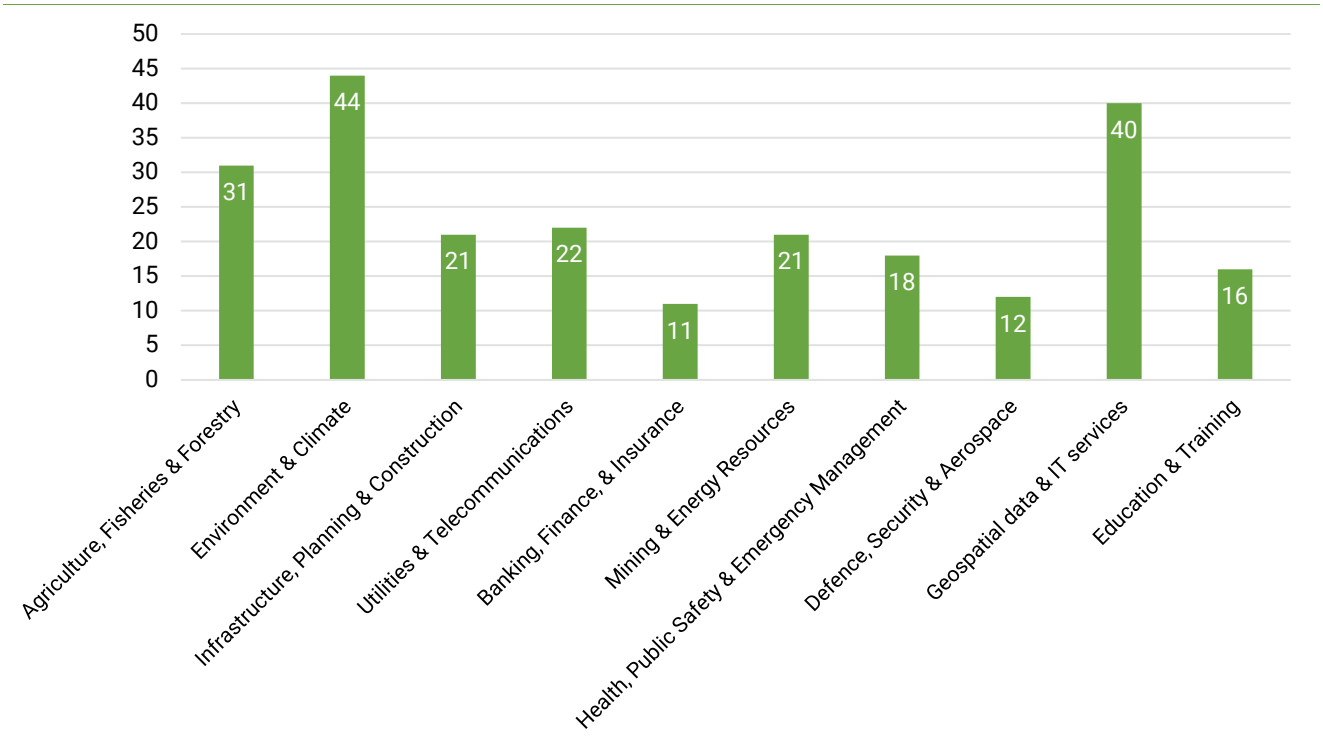


Figure 4 - Engaged Stakeholders by Market Sector

This highlights the differences in maturity of adoption of EO in each of these sectors. For example, exploiting EO for agriculture, environment, and climate, is relatively mature, whereas the presence of EO data to service the finance and insurance market in Queensland specifically, is likely less mature, meaning knowledge of EO and its potential, is likely to be more limited in these underrepresented sectors. This also provides a future opportunity to engage with these sectors and encourage uptake of EO and development of new tools, products, and services specific to those sectors.

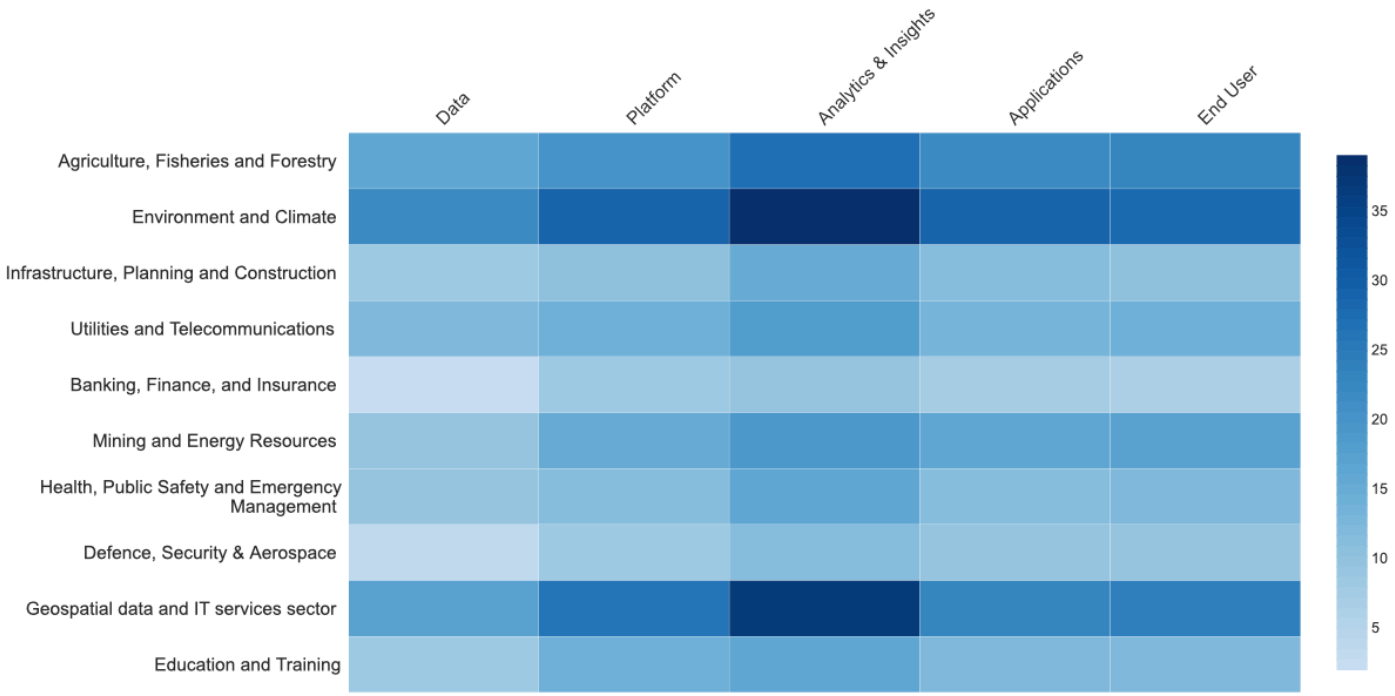
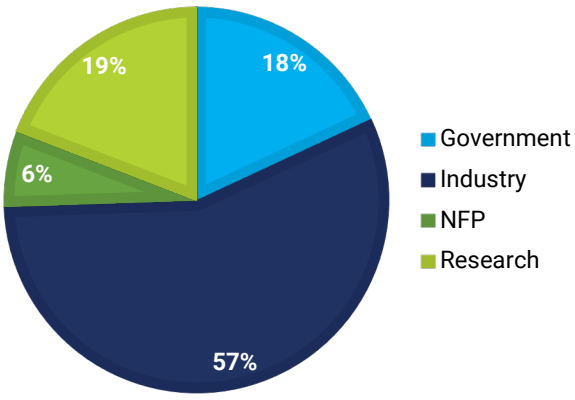


Figure 5 - Overview of engagement by sector and value chain



Engagement efforts intended to speak with as broad an audience as possible with a clear focus on gaining an understanding of the future needs for Queensland EO sector organisations and stakeholders (Figure 6). This broad engagement has been successful, and we are pleased that we have been able to engage with those working in industry (57% of engagement), who can tell us about the areas of application that have the greatest need for growth and adoption, with engagement with the research sector (19% of engagement) who are developing the latest technologies for commercialisation, and engagement with government (18% of engagement) and the not-for-profit sectors (6%).

Figure 6 - Participant organisation type across all engagement

5. KEY FINDINGS

This section presents a Queensland EO community and landscape that has strong foundations, significant potential and desire for growth, and a common set of challenges, gaps, and opportunities shared across Queensland's key stakeholder and sectors groups, and across the whole EO value chain.

The sections below present the key findings and takeaways, grouped by the common themes (Figure 7).

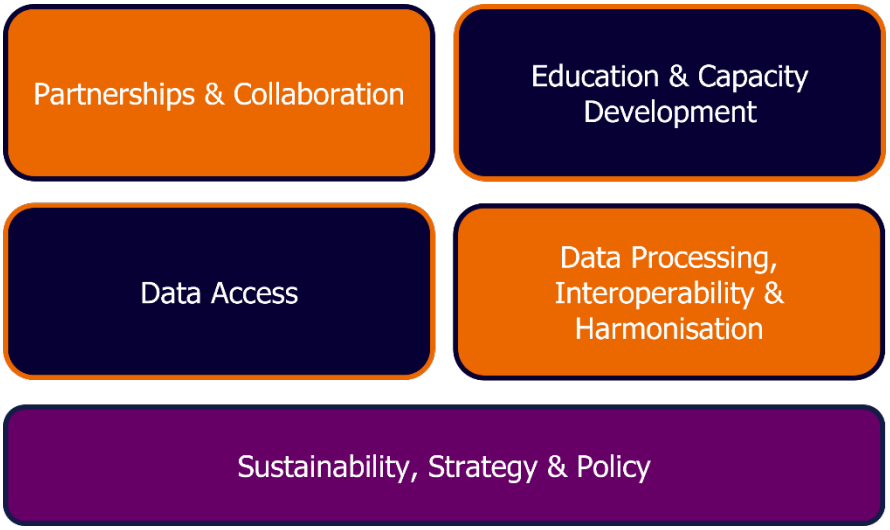


Figure 7 - Common Themes across Sectors & Value Chain Segments

Figure 8 - Word cloud comprising of most referenced words during stakeholder engagement

5.1 Queensland's Strengths in Earth Observation

A key finding from this research was that there is a consensus that Queensland is a strong actor in Earth Observation in Australia with strong potential for growth. However, despite these positives, it is not without flaws and several recommendations emerged to strengthen the EO sector in QLD.

5.1.1. Opportunity Rich Environment

Queensland is considered an opportunity rich environment; its vast geographical area and climate lends itself to the adoption of EO. Favourable weather, clear skies, and the need to monitor vast remote areas, means that EO is uniquely suited to address these needs and provide the opportunity to develop EO based solutions, products, and services, with the potential to improve efficiencies and reduce costs of operational decision making. Findings from the market study indicate that there is potentially a huge opportunity in QLD to develop products, services, and applications for various market sectors. For example, the agriculture, mining, and natural resources sector are extremely active in QLD, with these sectors contributing significant to the economy and considered to be key income for the state (For example, as of 2019-2020 mining contributed 11.7% to the QLD economy, a total of $39.6 billion (QLD Gov 2020)).

Stakeholder engagement found clear evidence that there are significant opportunities for boosting already strong activities providing data and services to a national and international audience. We It was also found that EO operations and end users in Queensland are spread reasonably evenly across urban and rural areas, indicative that demand for data, analytics and insights is not limited to Southeast Queensland but has active demand statewide (Figure 9).

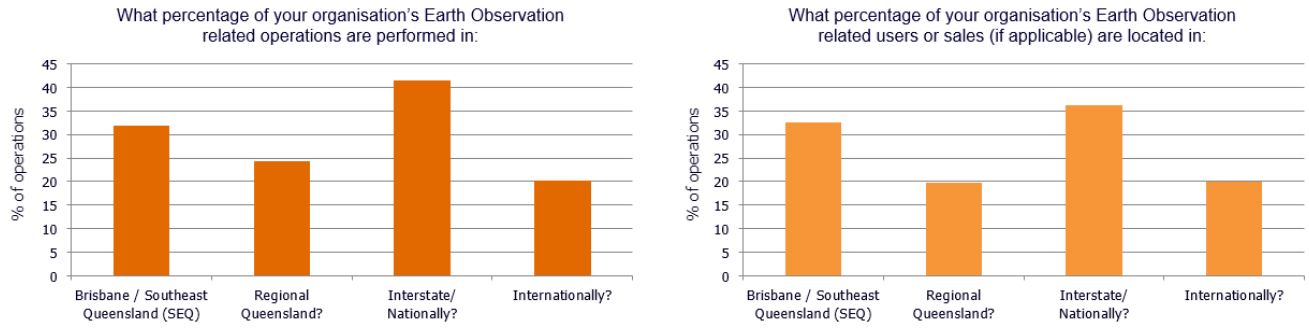


Figure 9 - Current use of Earth Observation by geography

5.1.2. State Level Approach to EO

Participants reported that in their opinion, Queensland has a good approach to deriving value from EO data and technology, however this opinion was not shared by all stakeholders consulted. Our findings demonstrated that several actions undertaken by the Queensland Government have been well received by the community. These include that 'Queensland government is at the Forefront of EO Investment' and that the current State Imagery Program and Open Spatial Data initiatives have been very successful and is a model which should be continued both in Queensland and replicated in other states. Overall, participants reported that they thought the Queensland Government state strategy was good, however expressed concerns about sustainability, particularly with change of government, and external political influence at the federal level as a risk factor for longer term sustainability of the EO sector.

5.1.3. Research & Teaching Capacity

Queensland is considered to have excellent EO teaching and research capability, this is recognised both nationally and internationally, and is evidenced by long standing international collaborations between academic institutions in Queensland and strategic global partners such as NASA and ESA. Queensland is considered to have a vast network of EO experts and practitioners, providing skills and expertise to the entire EO Value Chain.

Similarly, QLD has an established history of excellent research into calibration and validation. Many Cal/Val sites have been established and are actively maintained by researchers in Queensland. Calibration and validation of satellite-based sensors is also undertaken in QLD, due to its unique geography. For example, CSIRO runs the Lucinda Jetty Coastal Observatory, which is a ground-based observatory, located approximately 6km off the coast near the mouth of the Herbert River, in Queensland. The observatory is used to validate optical satellite observations, in collaboration with ESA, it forms the only permanent ground-truthing station for the Sentinel satellites, a key component of the EU's Copernicus Programme (CSIRO, 2023).

5.1.4. Primed for Growth

There was strong response that those engaged expect either growth or significant growth in how they use EO within their organisations over the next few years, with some, across most sectors, planning for complete transformation. These findings were strongest in sectors relating to mining, environment and urban planning applications (Agriculture, Fisheries and Forestry sector, Environment and Climate sector, Utilities and Telecommunications sector, Mining and Energy sector, Infrastructure, Planning and Construction sector).

Reasons for this include expected increases in data availability and accessibility, that the power of EO is becoming more widely acknowledged and recognised, and that all parts of the EO value chain will continue to provide stronger value and return to the Queensland economy.

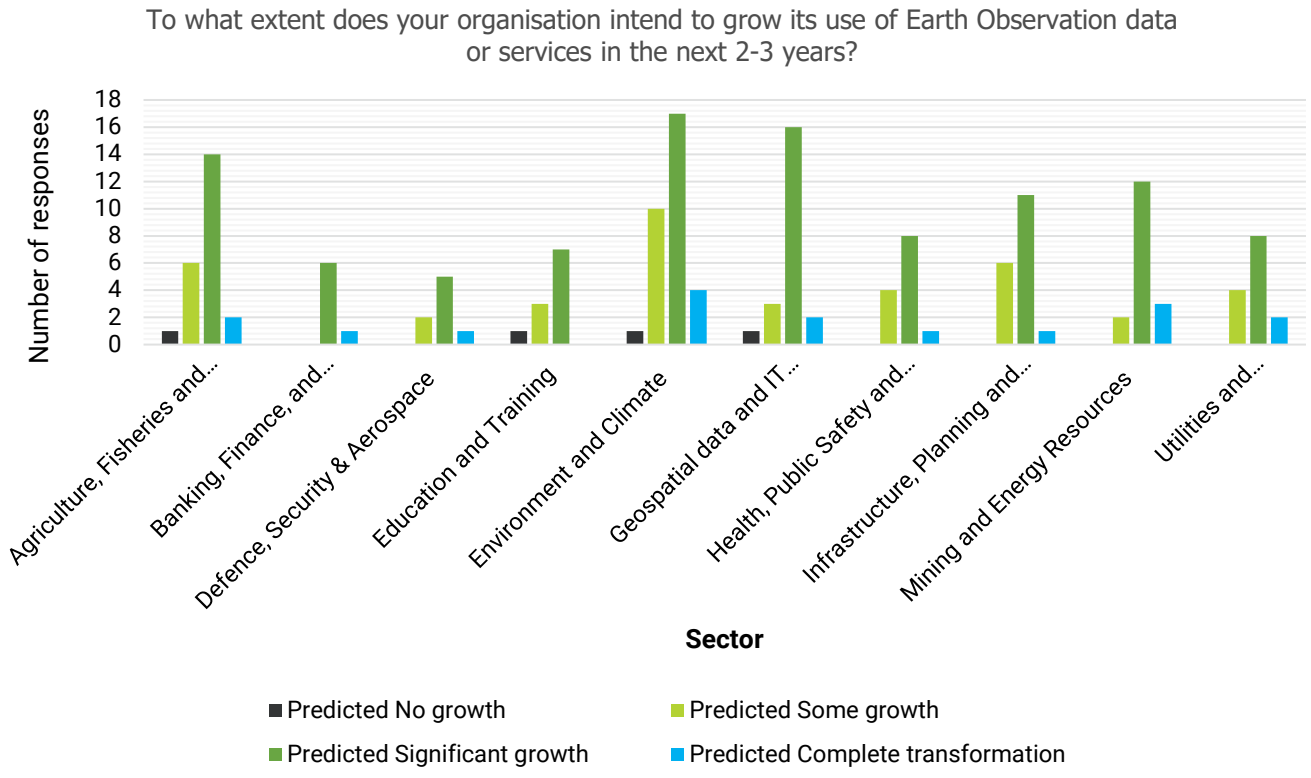


Figure 10 - Reported degree of growth in use of EO by sector

5.3 Challenges & Opportunities

The core challenges and opportunities and potential ways to address them, identified by participants have been grouped into the five key themes, outlined in Figure 7. The results in this section are summaries from responses from the survey, interview, and workshop participants through the stakeholder engagement process.

5.3.1 Partnerships & Collaboration

Building National Partnerships & Collaboration

The market study highlighted that partnerships and collaboration are considered to be a critical component of an effective and successful EO market. Whilst recognising that Queensland does have excellent capability and undertakes world leading research with international research partners, those surveyed thought more could be done to strengthen those collaborative partnerships, and further build the community, both nationally and internationally, from both an industry and academic perspective. Stakeholders from industry, research and government expressed a keen willingness to build closer collaboration, to address a variety of gaps and challenges that have been identified.

Fragmentation of EO Community

Participants expressed their concern that presently, the EO community is fragmented, with limited communication and collaboration between organisations, and even between departments inside organisations, leading to lack of transparency and understanding of the needs, current activities, and opportunities to collaborate. Disconnects between suppliers and customers are also reported, resulting in misalignment between services and needs, and missed opportunities.

Examples included cases of duplicated effort when developing EO products which have an applied use by various actors in the community, e.g., 'swimming pool detection algorithm' which was highlighted as an example where efforts to produce a useable product have been duplicated by more than one organisation. Likewise, insufficient end user collaboration leads to creating products and services that are not fit for purpose, ultimately threatening the long-term sustained use of these products by users and eroding trust in the capability of EO as a data driven technology solution.

Whilst it was recognised that there are existing initiatives to foster public-private partnerships, for example via collaborative research grants, it was suggested improvements could be made to these processes to increase industry participation in academic partnerships. If the process was more streamlined and less complex, there would be more appetite to participate.

Increase Engagement & Communication between Industry and End Users

Some participants suggested the QLD EO sector would have an opportunity to grow if start-up and small EO companies had more opportunities to communicate directly with end users, for example, state and regional government agencies. They considered these agencies can tend to look to national (government) EO services, irrespective of the state of development of that service. Collaboration to identify new opportunities for growth of the EO sector by engaging with end users in various sectors could help to determine whether EO is an appropriate solution. By bringing interested parties together and adopting a user centred design approach, users have an active role in the design products and services that are fit for purpose, and technical and sectoral experts manage expectations and design a solution that is both technically viable and able to meet requirements. Local capabilities and outcomes could be applied and exported internationally.

It was suggested, that by connecting EO stakeholders to end user communities in market opportunity sectors and approach solution design using a bottom-up approach, for example via user-led challenge workshops, then more

opportunities will open. Bringing providers and consumers together will help foster long-term sustainability, this could be achieved by building a community to increase knowledge transfer between interested stakeholders to facilitate a wider understanding of industry needs, share information about who is doing what to facilitate the opportunity to collaborate on product design for commonly used products and services to generate fit for purpose products for all interested stakeholders enabling improved efficiencies and data sharing, as well as a reduction on costs. Likewise, promoting awareness of private sector capabilities across Federal, State, Universities and CSIRO, could help bridge the gap between industry, government, research, and decision makers.

Increasing International Partnerships & Collaboration

Whilst both national and local (state) partnerships have been widely discussed, a strong emphasis and desire to collaborate with the international community emerged. Various challenges are seen as currently blocking economic growth. For example, local EO companies report difficulties entering international markets, and would greatly benefit from support and guidance into how they can scale outside Australia. It was noted there are great opportunities in emerging regions such as the Pacific, Africa, and South America, and the opportunity for small business to participate in overseas trade missions could be fruitful and enable export to international markets.

Some participants considered that Australia has an over reliance on foreign upstream capability (e.g., NASA, ESA) and international data, as well as over-reliance on international standards and practices for data interoperability and harmonisation. Whilst engaging with the international community is undoubtably fruitful, it was thought the needs of Australia in these discussions are not always met. As an example, The Committee for Earth Observation Satellites (CEOS) established their Analysis Ready Data for Land (CARD4L) standards, however some have questioned as to whether a globally focussed standardisation is fit for purpose for Australia's needs and unique geography. It was suggested these issues could be mitigated by promoting the expansion of Australia's Sovereign capability, which is falling behind those of other developed nations.

Commonly cited opportunities for building partnerships and fostering collaboration are outlined in Figure 11.

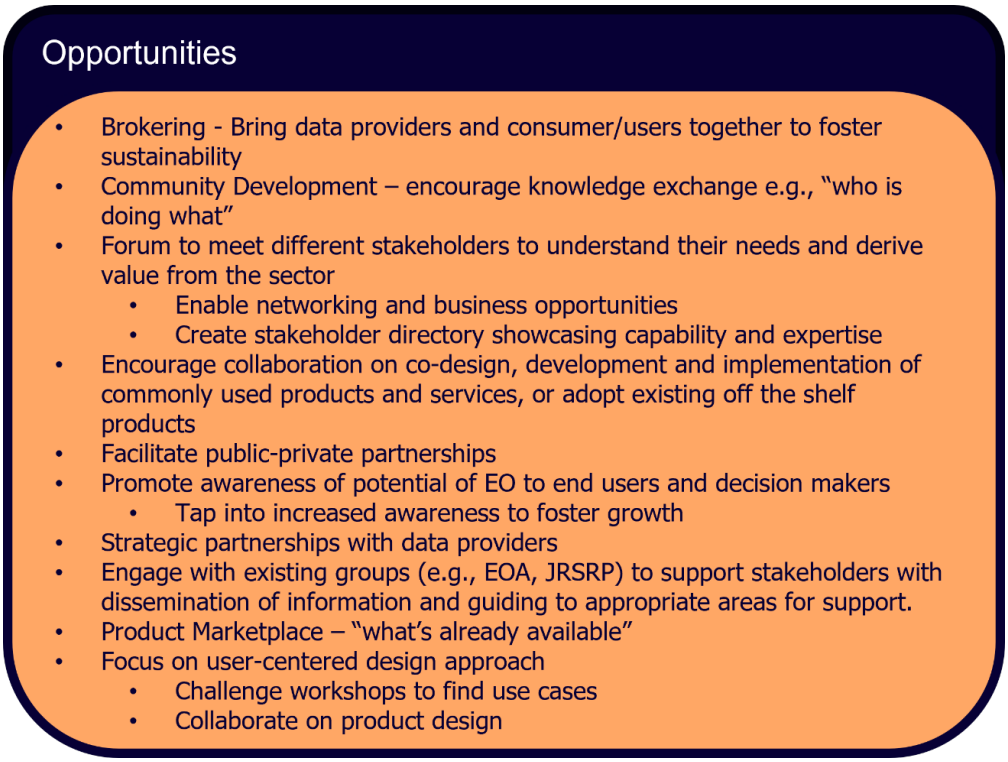


Figure 11 - Opportunities for Partnerships & Collaboration

5.3.2 Education & Capacity Development

Education and capacity development was raised by the majority of stakeholders who were engaged as part of this market study. Whilst there is widespread recognition that Queensland currently has excellent university post-graduation education in remote sensing and GIS, as well as excellent research, some gaps remain regarding how prepared graduates are for the workforce, with stakeholders reporting that whilst graduates often leave tertiary education with good technical skills, they often lack the complimentary skills such as project management, people management, ability to successfully write proposals for funding and project/solution design.

Consultation between Academia & Industry on Skills Needs

It was suggested there is an opportunity for academia to consult with industry on their workforce needs and bring these recommendations into their teaching curriculum for EO courses. This would help ensure graduates are equipped to enter the workforce immediately after graduation.

EO is recognised as an emerging technology sector, as technology advances, more sensors are launched and with it the need to be able to process this data efficiently and at scale. This presents challenges for the existing workforce in their ability to stay up to date with recent technology developments, often due to budgets, resources, time required or lack of clear alignment to the commercial objectives of the organisation.

Staff Availability, Capacity & Staff Retention

More broadly, stakeholders expressed that they experience problems with skilled staff availability, capacity and staff retention. Resource constraints can make it difficult to attract and retain talent, particularly with the well documented technical skills and workforce shortages impacting the EO market.

It was proposed there are opportunities to help address skilled staff capacity and capability shortages in a more coordinated, efficient and sustainable way, through the creation, collation and delivery of centralised training resources to both upskill and reskill existing and new EO workers.

Specific Gaps in Capacity & Skills – Synthetic Aperture Radar (SAR)

Regarding specific skills gap in the existing workforce, there is currently a considerable skills shortage for expert processing and analysis of Synthetic Aperture Radar (SAR) data. Despite the large number of skilled individuals working in the Queensland EO sector, most do not feel comfortable working with SAR data with their current skillsets. It was also reported that there is a skills gap regarding translating raw data into an aggregated data product that are ready to go, fit for purpose and plug and play for analysis.

Specific Gaps in Capacity & Skills – AI and Machine Learning

There are insufficient skilled workers with expertise in AI and machine learning, who can apply these techniques to EO data at scale, to improve efficiency. Similarly, stakeholders reporting skills gaps with prerequisite quantitative data analysis and visualisation tools (e.g., analytical computer programming), data simulation, calibration, and validation, and working with cloud computing platforms (software programming).

Specific Gaps in Capacity & Skills – Adopting a Multidisciplinary Approach

Stakeholders also reported the need to adopt a multidisciplinary approach, EO is a valuable tool, however benefits would be greatly realised by bringing together subject matter experts from other specialties (e.g., ecologists) together with data engineers, to cross-pollinate between sectors and skills, and to co-design the most appropriate product or service to meet a user's need, using a demand driven approach.

Specific Gaps in Capacity & Skills – Increase Understanding of the Potential for EO

During the market study, it was frequently raised there is a strong need to better educate and share knowledge with decision makers and end users on the benefits of EO and advancements in technology, to better facilitate increased investment and uptake to support operational decision making. It was considered the greater the understanding of the potential for EO, the greater opportunity there will be to open new market sectors and facilitate the development of innovative products, platforms, and services.

Promote EO and Geospatial Careers

Finally, it was highlighted that often graduates are not fully informed about what EO and geospatial careers are possible. To this end, it was suggested improvements could be made in promoting EO and geospatial careers, via increased media promotion, or creation of geospatial career profiles.

Common identified opportunities for improvement for capacity development are outlined in Figure 12.

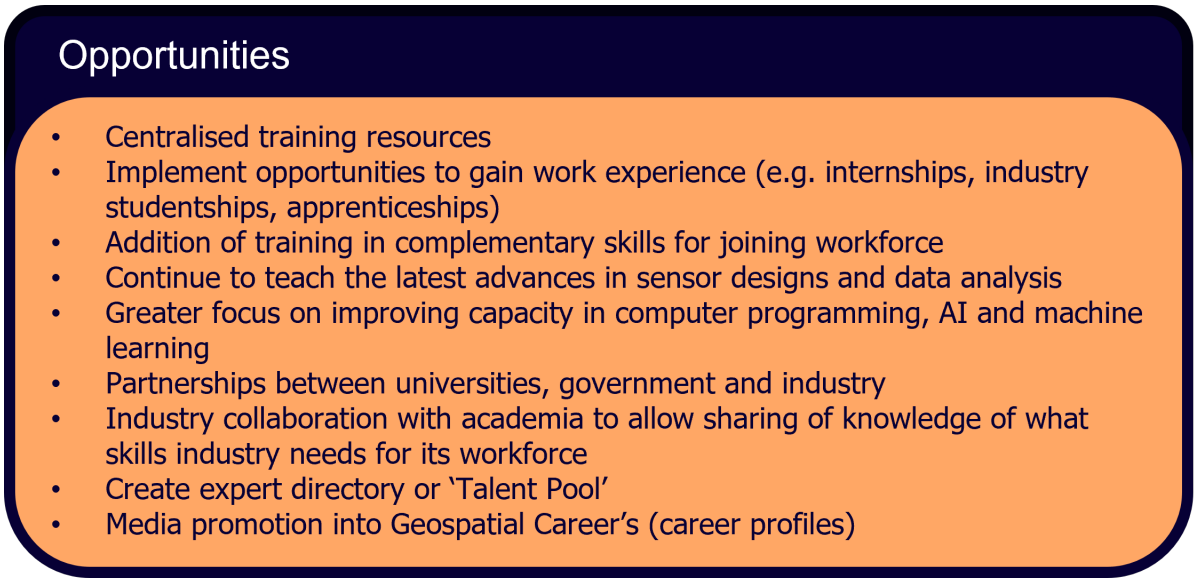


Figure 12 - Opportunities for Capacity Development

5.3.3 Data Access

Data Sharing, Accessibility, and Dissemination

Sustainable access to EO data has been highlighted as a key issue blocking growth of the EO sector, and that the sector would benefit from a combined state-wide approach for Queensland for sharing data, as one participant quoted; "data shared is value added" and thus data sharing could be incentivised. For example, it was suggested if the QLD Government's archive of drone data is made available to the community it could enable development of products and services, and validation of existing products. Once proposed solution, was the creation of a Centralised Data Repository, which would be beneficial for enabling data sharing across the community. By breaking down silos between organisations for data sharing, there is an opportunity to increase the value and economic return.

There was some discussion about how different business models and approaches to data licensing and IP could encourage new insights and applications. For example, sharing existing data to derive additional insights (e.g., building outlines, building heights). The new insights could be provided back to the license holder under an unrestricted license with the rights to sell the new insights remaining with the entity who undertook the work.

Access to Affordable High-Resolution Imagery

Access to affordable high-resolution imagery that is current and frequently captured was often cited as a challenge; commercial data incurs a high cost for a user license, limiting its adoption by resource constrained organisations. There is a clear need for increased data supply, particularly for data with spatially Very High Resolution (VHR), as well as a high temporal resolution. It is also considered to be difficult to distribute EO data, as no unified network for potential customers to find EO data currently exists, with some companies making this harder still by requiring the use of a 'middleman.' (Rotoiti Consulting, 2020). It was suggested that by working collaboratively, it may be possible to pool resources for access to commercial imagery, sharing these resources for the benefit of all stakeholders. It is noted however, that data end user licensing restrictions often hinder the adoption of this approach. The QLD Government have made great progress through their Spatial Imagery Program and their Open Data Policy, and participants considered securing future investment to continue this program would be greatly beneficial for the sector.

Inflexible Licensing Arrangements

As a community, encouraging data providers to adopt flexible licensing arrangements would also prove beneficial. Engaging with small businesses who are experimenting with disruptive licensing and operational models, for example a reduction in the minimum order size for imagery, could provide the flexible arrangements required to increase return on investment on large data procurement contracts, and in turn open this data use to more users. It was suggested supporting the FAIR approach for data, ensuring it is 'findable, accessible, interoperable and reusable', will further help promote better licensing.

Participants noted physical access to data is not the only blocker, it's well documented globally that the EO industry faces issues with restricted data licensing. Large international satellite operators such as Maxar and Airbus can effectively hold a monopoly on the market due to their mature, established status, available resources, and advantageous position as the asset operators, this however reduces opportunities for small businesses, who have established themselves to disrupt the market for data access. These smaller companies often don't get a seat at the table for large procurement contracts. Issues with restricted licensing also complicate the argument for large scale data collection using satellite, as licensing often restricts ability to share data.

Presently, there is a state government led coordinated imagery acquisition program which acquires earth observation data under a shared license by subscription paying agencies and organisations. However, this program is still limited in that it shares only older data as public and open data. Enabling a licensing model providing greater flexibility and access to shared data could open significant opportunities to develop products and services for a wide variety of use cases. Promoting and implementing cost-effective less restrictive licensing for satellite imagery could rapidly grow demand as the aerial imagery market is saturated and Air Traffic Control (ATC) flight restrictions are only getting worse, thus limiting available collection windows.

Data Needs & Gaps – Increase Australia's Sovereign Capability

Whilst the EO community in QLD has greatly benefited from access to data from both open-source and commercial satellite programs, the community highlighted that current sensor technology does not meet all the needs for QLD. It's been raised that existing data streams do not provide data at high enough resolution, low enough cost, with a high and reliable revisit frequency, with the low data latency (real time collection and delivery) required to develop actionable insights in near real time. By breaking down barriers to access, users could be incentivised to integrate EO into their value chains. In response, there is a desire to increase Australia's national upstream capability. Increasing sovereign capability in upstream technology could potentially reduce Australia's reliance on international vendors and make available more Australian focused data. It would also elevate Australia's position as a global player in the EO market, It was noted the Australian Government's $1.2 billion National Space Mission

for Earth Observation would have supported increased availability of Australian focused data but was cancelled in May 2023.

Common identified opportunities for improvement for data access are outlined in Figure 13.

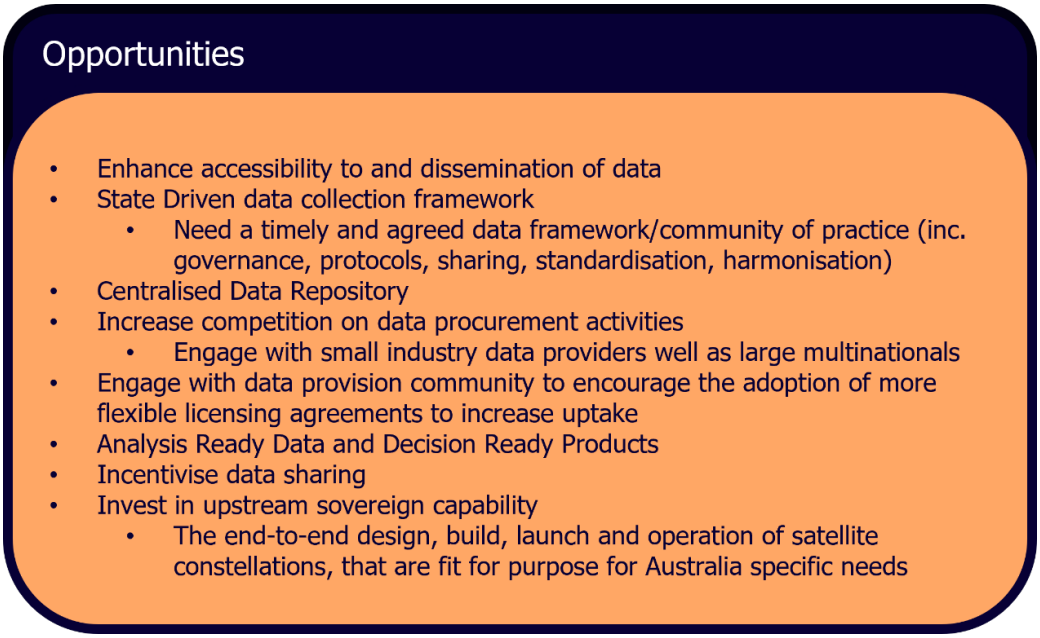


Figure 13 - Opportunities for Data Access

5.3.4 Data Processing, Interoperability and Harmonisation

Significant uptake in use, particularly by those outside the EO and GIS sectors has increased the awareness and demand for EO data. As decision makers are becoming more aware of the capabilities of EO data and its limitations, the data processing required to get a usable product for analysis is becoming more streamlined, however often products are not fit for purpose. There are several challenges to explore, including data processing, interoperability, and harmonisation.

Big Data Processing

Participants reported several challenges with large scale data processing. With the deluge of EO data coming online, it's necessary to adopt methods to facilitate rapid processing and analysis of these data streams at scale, to allow for the timely delivery of decision ready products. Technological advancements in recent years, for example increased access to GPU High Performance Computing (HPC) infrastructure and scalable distributed computing solutions offered in the cloud (e.g., AWS, Google Cloud, Azure) have gone a long way towards easing this data consumption burden and have allowed for processing large time-series of data. However, the investment needed to set up a data processing pipeline can be large, especially as additional data is often fused with EO data, requiring additional expert knowledge (Rotoiti Consulting, 2020).

Initiatives such as Digital Earth Australia (DEA), and Google Earth Engine (GEE) have made great advancements in provisioning scalable infrastructure at a comparatively low cost to the user, however not all users are able to adopt these platforms, due to the need to fuse other source data with EO data to further deepen actionable insights, which introduces issues such as data security and privacy. Not everyone is able to share ancillary data with platform operators such as Google. Similarly, not all organisations have the support for such scalable infrastructure needed to work with EO data. It was cited that a challenge experienced included limited support or

buy-in from organisational IT departments to establish such infrastructure and to integrate EO products into existing in-house spatial systems.

Raising awareness and championing these existing solutions and gaining recognition of their value outside the EO community could help to garner the support needed to increase applied uptake of EO, as more users can access compute at scale, which will aid the development of custom models and solutions. In terms of advancements of tools and approaches for processing and analysing EO data, there is a need to explore ways to analyse at scale, via AI and machine learning, and a reported shift towards block-based coding, which reduces the barrier for entry to using EO data.

Limited Data Interoperability

Data interoperability allows data to be unified and used together, despite being in diverse formats and from different locations, a common problem experienced by the EO community in Queensland that emerged during this market study. There has been a global shift towards improving data interoperability, and adoption of the FAIR principles is gaining traction. Despite this, much of the existing data, products, code repositories and platforms, do not currently conform to this ideal. Stakeholders reported frustration with data interoperability and cited that 'datasets produced are often provided in a format that is not ready for consumption and first need to be turned into a workable data format' which introduces time and resource constraints. By improving interoperability, the community can move towards the creation of data products that are fit for purpose and ready to be used in analysis, frameworks, models, or tools; 'decision-ready'. Reducing these barriers could help foster growth of the EO market and improve consistencies in data and reporting.

Data Harmonisation and Fusion

We live in a data rich world. By investing in efficient data processing and exploiting the huge volumes of data being continually collected it will become increasingly possible to create consistent data products that can be compared across time and increase the ability to combine disparate datasets using data fusion. The opportunity exists to explore further data fusion options both within the EO space, e.g., ground-drone-satellite integration across sensors, and via integration with context/sector specific data, by joining EO and socio-economic data.

Data harmonisation, building consistencies between different types of data sources, is something that the EO community voiced as a desired focus area, for example working to make different types of remote sensing data which are currently in different resolutions and not in the same format, work together to leverage benefits of each. To date, efforts have been made to harmonise Landsat and Sentinel-2 data (Claverie et al, 2018). Outcomes would be greatly improved if the community worked together to move towards the creation and adoption of a timely and agreed framework or community of practice which focusses on the challenges of data access, interoperability, and fusion. Such a framework would need to address data governance, protocols, sharing, standardisation, and harmonisation and recommend best practices. Alternatively, adoption of existing international standards, where available, would be a valuable activity.

5.3.5 Sustainability, Strategy & Policy

Developing effective strategies and policy

Sustainability for the EO market in QLD was identified as a high priority by the stakeholders consulted, who cited that growth in the EO sector, including industry and research, would be underpinned by the direction of an overarching government strategy or roadmap. Other uncertainties mentioned included changing political priorities and inertia, which might threaten funding, meaning funding streams are at risk of becoming "unreliable and

inconsistent". Examples include changes in government policies in relation to the space industry. The opportunity is for continued and consistent investment in knowledge exchange and workforce development to ensure long-term sustainability for the market.

Raising Awareness for Collaborative Investment

Industry will expand their R&D investment in line with their current and projected portion of market share. Greater federal and state government support to small business and industry would grow the market, for example via expanding local content procurement processes, or through other government levers. Growth, by definition, is not growing university and government, instead sustainable growth of the EO industry will be commercially led with university or government partnerships/clients.

Identifying a mechanism for better collaboration and cross organisational linkages between government, research and industry could incentivise public-private partnerships, such as collaborative investment into HPC, cloud computing and EO data storage infrastructure. Similarly, actions could be taken to identify ways to protect long-term open data collection opportunities for use across the industry.

Greater awareness and understanding from those in decision making and managerial positions could result in greater buy in to the technology and create advocates and champions for sustainable long-term adoption. Developing collaborative state industry programmes and strategies to implement recommendations, could help attract investment by demonstrating cohesion and a common strategy, which could further propel Queensland as a centre for EO excellence, and attract funding, R&D and investment. Historically, data is not considered a capitalised asset, despite the multiple insights and use cases that can be extracted from a single dataset. A change in attitudes to consider data as a capital commodity would increase value.

Whole of economy cost savings and efficiencies could be gained by collaboration between sectors turn move towards sustainable commercialisation. This could be implemented through greater partnership and collaboration to create and exploit commonly used products and services, such as land use, land cover, and associated changes, for the state. Traditionally, the generation of these critical products has been uncoordinated and not funded in a sustainable manner. Implementing a strategy to protect long-term sustainability, is seen as critical to future success and growth. Common identified opportunities for improvement for sustainability, strategy and policy are outlined in Figure 14.

Figure 14 - Opportunities for improved Sustainability, Strategy & Policy

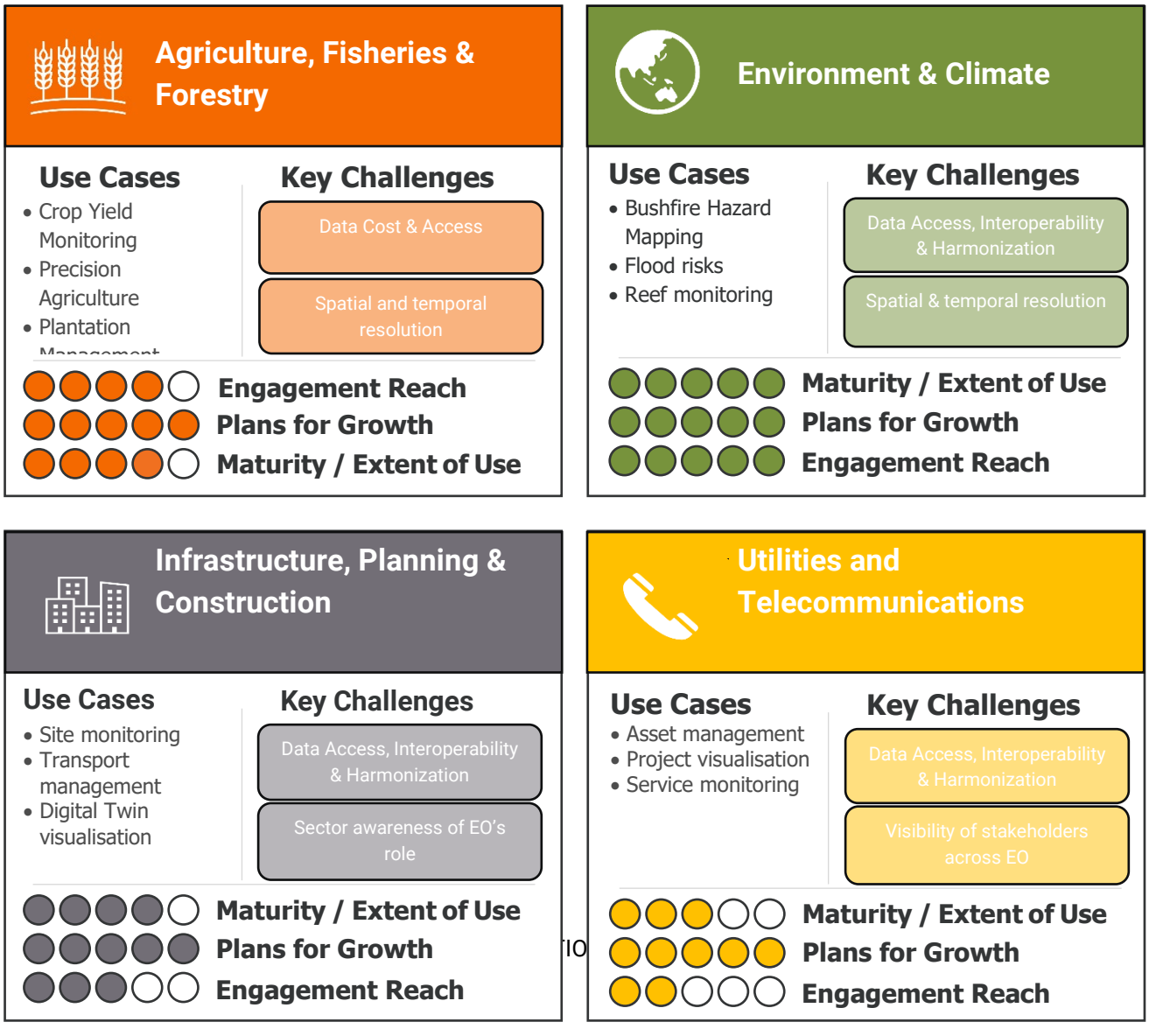
6. SECTOR AND VALUE CHAIN SPECIFIC INSIGHTS

This section explores implications of the key findings provided in Section 5 for organisations that operate across different sectors. Within each sector, insights around current challenges and future opportunities will be provided as relevant across the EO value chain. To note, most of the findings from the market study applied to the whole end-to-end value chain, however where sector and value chain specific insights were available, these have been documented.

6.1 Sector Insights

The sector analysis revealed that most highlighted opportunities and challenges were relevant and applicable for each sector consulted. However, the findings show some sector specific challenges and opportunities, for example, the study highlighted that Health, Public Safety & Emergency Management were concerned with a need for higher temporal resolution data to respond to events in real time, in addition to access to higher spatial resolution data to gain improvements in localised monitoring on smaller scales with more detail. Likewise, Agriculture, Fisheries and Forestry and Mining and Energy Resources were looking for higher resolution data or access to reliable hyperspectral data to further improve crop yield estimation, mineral prospecting, and environmental monitoring for mine closures.

The key sector-based findings are summarised below (Figure 15). Supplementary charts showing additional sector findings are presented in Appendix III – Detailed Results by Sector.



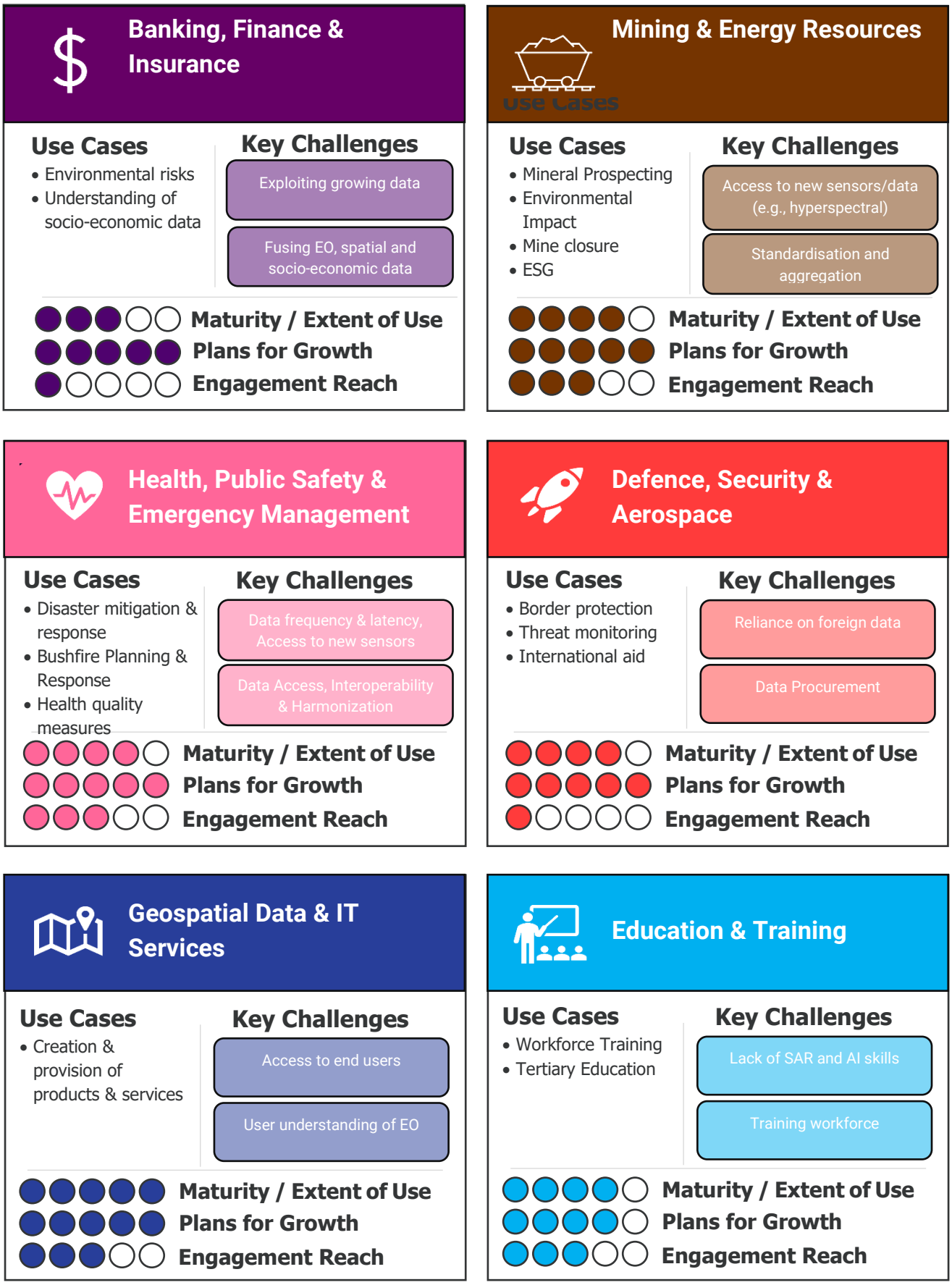


Figure 15 – Overview of Key Sector Based Findings

Mining and Energy Resources reported a need to align activities with government strategy, such as QLD Government's Critical Minerals Strategy. Environment and Climate who reported their desire for better data access and sharing, improvements to temporal resolution of data as well as improvements to be made with data interoperability and harmonisation, to continue to undertake critical environment and climate monitoring. Aerospace, Security and Defence highlighted that currently Australia is over reliant on foreign data, and that policy barriers exist regarding data procurement. Across the board, there was a strong desire to deepen engagement and collaboration with end users, to identify opportunities for growth and commercialisation. Concentrating on detailed sector focussed engagement going forward may reveal additional sectors specific insights.

6.1 Value Chain Insights

Summary insights split by value chain have been presented. Participants responded that their use of EO forms a component across most of the value chain, with a reasonably even distribution of use across each value chain segment (Figure 16). The most projected future use of EO across the value chain has been reported to likely occur in data acquisition and platform infrastructure and data dissemination are predicted be the most developing part of the value chain across all sectors, however growth is expected across the whole value chain with >95% participants reporting expectations of some growth (Figure 17). The use of EO in the value chain, segmented by organisation type, is presented Figure 18.

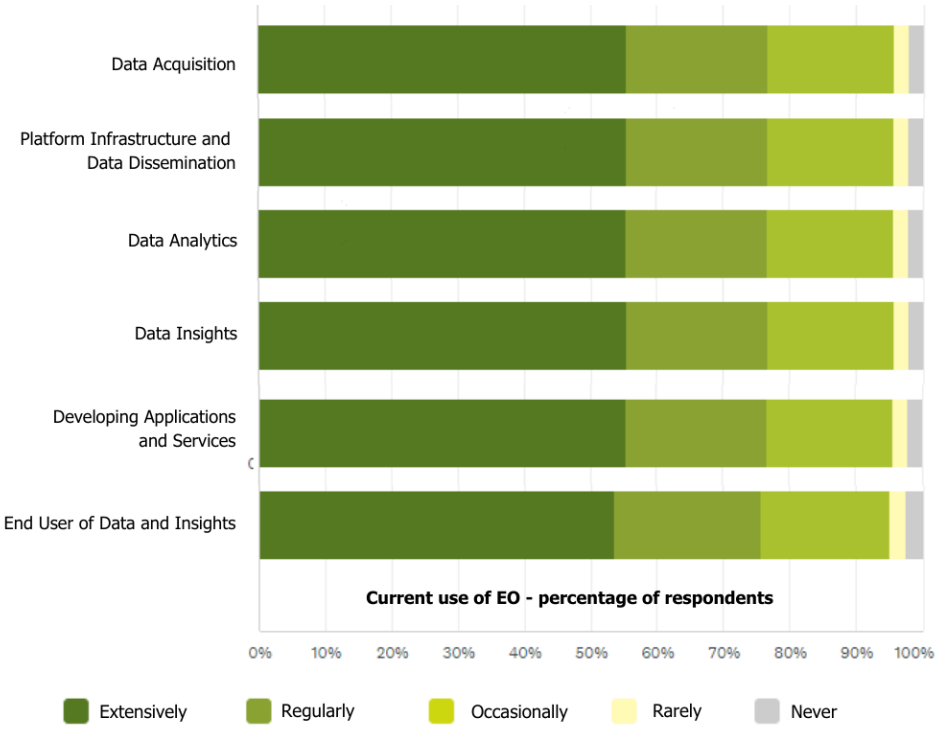


Figure 16 - Current use of EO by value chain

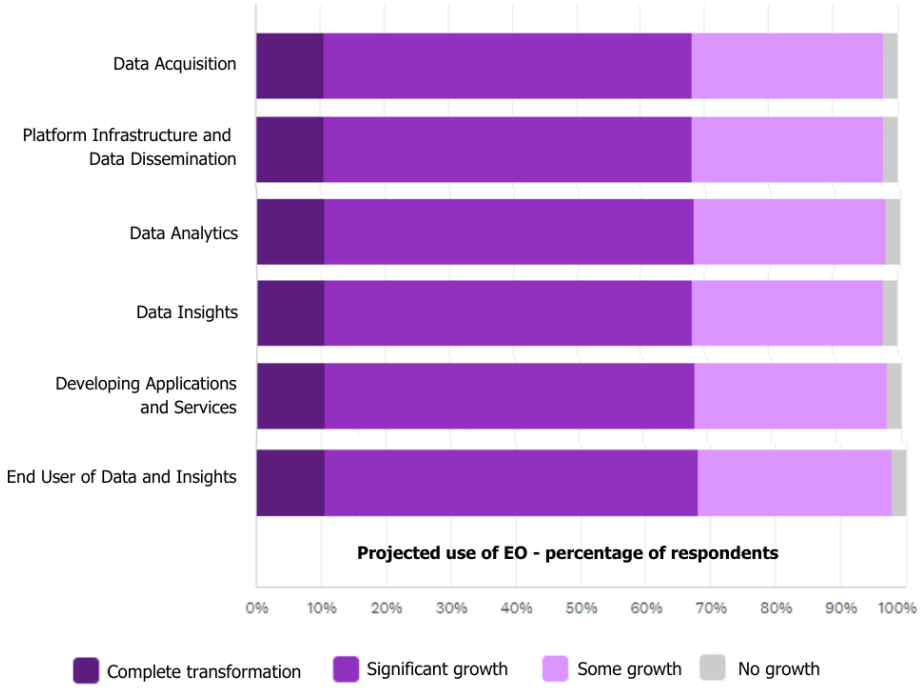


Figure 17 - Projected use of EO by value chain

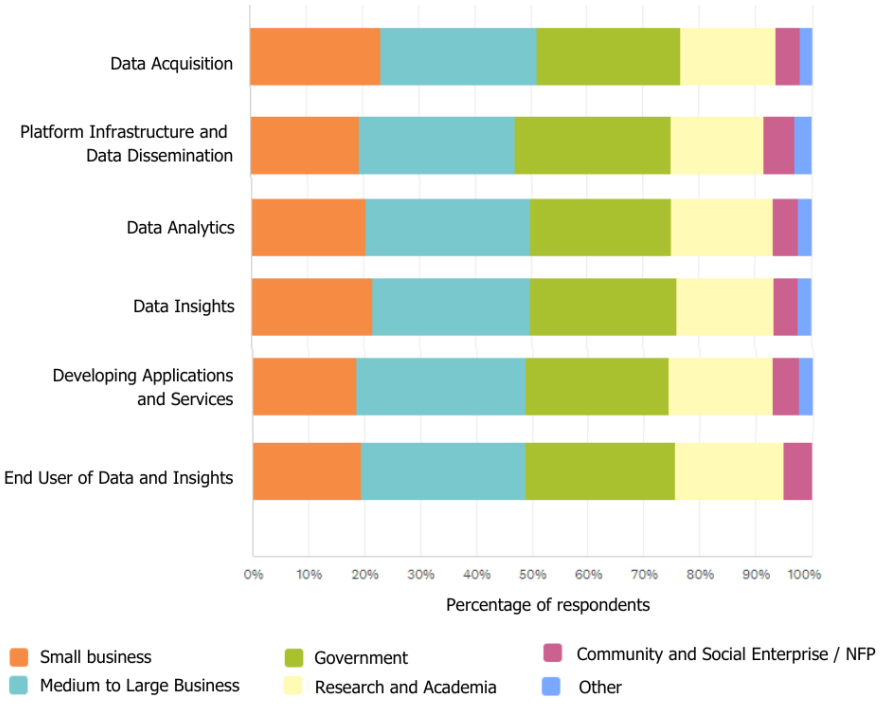
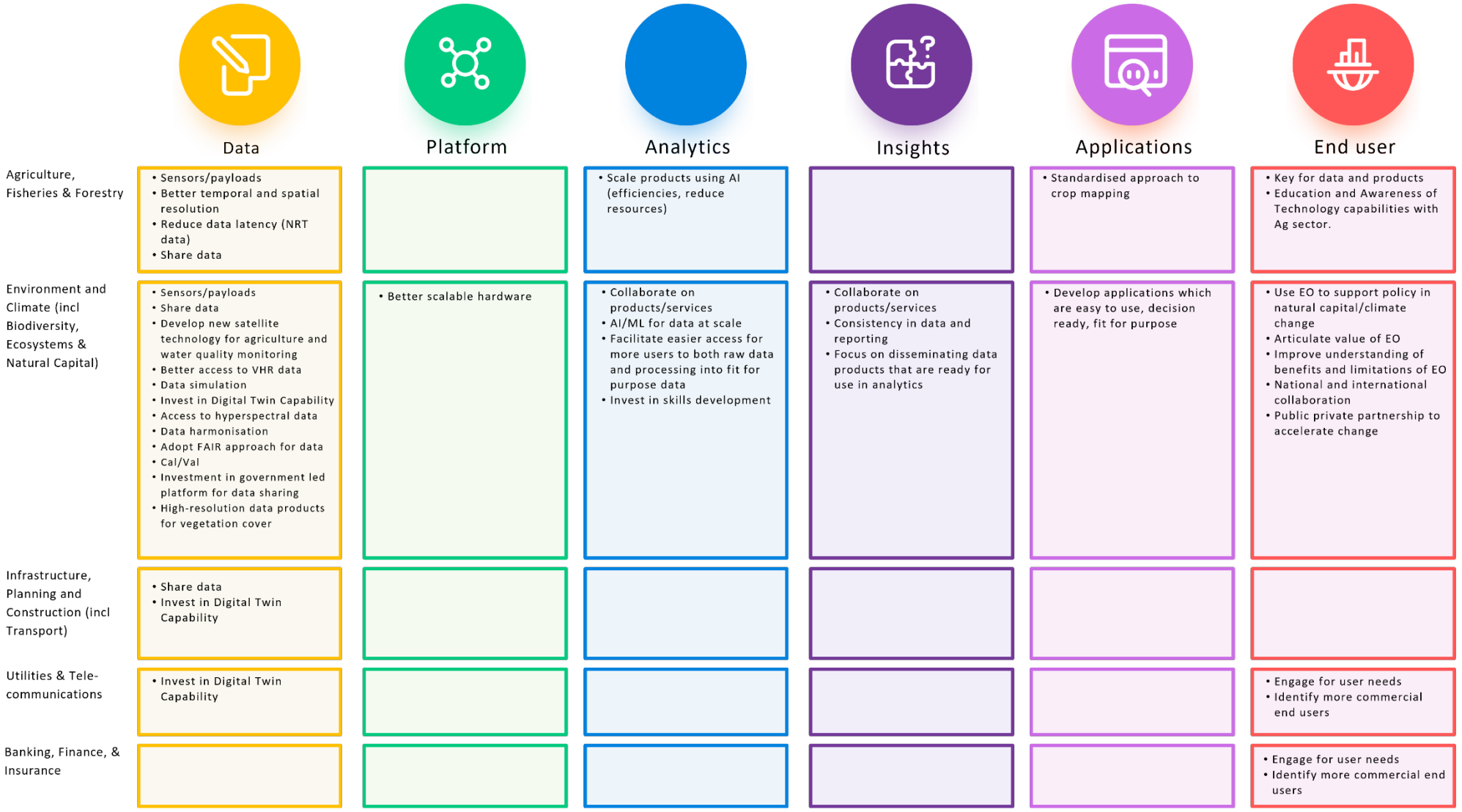


Figure 18 - Types of organisations using EO by EO Value Chain.

6.2 Sector and Value Chain Summary



	Data	Platform	Analytics	Insights	Applications	End user
Agriculture, Fisheries & Forestry	• Sensors/payloads • Better temporal and spatial resolution • Reduce data latency (NRT data) • Share data		• Scale products using AI (efficiencies, reduce resources)		• Standardised approach to crop mapping	• Key for data and products • Education and Awareness of Technology capabilities with Ag sector.
Environment and Climate (incl Biodiversity, Ecosystems & Natural Capital)	• Sensors/payloads • Share data • Develop new satellite technology for agriculture and water quality monitoring • Better access to VHR data • Data simulation • Invest in Digital Twin Capability • Access to hyperspectral data • Data harmonisation • Adopt FAIR approach for data • Cal/Val • Investment in government led platform for data sharing • High-resolution data products for vegetation cover	• Better scalable hardware	• Collaborate on products/services • AI/ML for data at scale • Facilitate easier access for more users to both raw data and processing into fit for purpose data • Invest in skills development	• Collaborate on products/services • Consistency in data and reporting • Focus on disseminating data products that are ready for use in analytics	• Develop applications which are easy to use, decision ready, fit for purpose	• Use EO to support policy in natural capital/climate change • Articulate value of EO • Improve understanding of benefits and limitations of EO • National and international collaboration • Public private partnership to accelerate change
Infrastructure, Planning and Construction (incl Transport)	• Share data • Invest in Digital Twin Capability					
Utilities & Tele-communications	• Invest in Digital Twin Capability					• Engage for user needs • Identify more commercial end users
Banking, Finance, & Insurance						• Engage for user needs • Identify more commercial end users

	Data	Platform	Analytics	Insights	Applications	End user
Mining & Energy Resources	• Access to hyperspectral data		• Align with government strategy e.g. QLD Gov Critical Minerals Strategy			• Engage for user needs • Identify more commercial end users • Use EO to facilitate community consultation and engagement
Health, Public Safety & Emergency Management (incl Humanitarian Aid)	• Reduce reliance on foreign data streams • Develop hardware capability for upstream sovereign capability • Improve procurement					• Educate end users
Defence, Security & Aerospace	• Reduce reliance on foreign data streams • Develop hardware capability for upstream sovereign capability • Improve procurement					• Engage for user needs • Align EO solutions with industry needs
Geospatial Data & IT Services	• Reduce reliance on foreign data streams • Share data • Connect with consumers/users of data • Better data licensing • Integrate EO data with socio-economic data • Engage with small data providers to disrupt market • Data Licensing • Secure stable funding for VHR data	• Improve infrastructure for processing data	• Educate on benefits and limitations of EO • Adoption of innovative and homegrown solutions.	• Develop 'out of the box' products to fast-track enablement		• Engage for user needs • Identify more commercial end users • Sector focused events • Promote EO capabilities to users
Education & Training	• Training for Cal/Val	• Develop HPC/Cloud skills	• Develop SAR Skills • Develop programming skills • Develop Data Simulation skills	• Develop programming skills	• Develop programming skills • Commercialisation of university inventions	• Educate on capabilities and limitations of EO • Increase information sharing

7. LIMITATIONS

This research study encountered various limitations during its delivery.

- *Limited stakeholder participation* - the timing of the study coincided with other Earth Observation focussed market studies being undertaken by Geoscience Australia and Earth Observation Australia, which resulted in 'survey fatigue'. Feedback was received that due to several other similar activities taking place, potential participants were limited in their ability to sufficiently participate due to time and resource constraints.
- *Insufficient diversity in study participants* - despite best efforts to engage with a wide array of stakeholders, from various backgrounds, sectors and gender, there was inadequate representation from voices in the Indigenous and First Nations Community in Queensland. Future efforts for market engagement in Queensland would greatly benefit from the inclusion of Indigenous and First Nations voices and opinions, as their input would provide invaluable insight into the specific challenges faced by those communities and provide opportunities to increase collaboration and engagement with these groups. Furthermore, the gender breakdown of study participants was not well balanced, with most participants identifying as male, with far fewer females participating in the study. This is representative of the composition of the Earth Observation and geospatial technology sectors, being globally known as being male dominated, and is a well-documented problem. Future efforts to engage with the Earth Observation sector in Queensland should consciously consider the role of women's voices in the debate, and make efforts to ensure greater inclusion, as women do make up a considerable amount of the geospatial workforce, their voices are just not often heard.
- *Insufficient engagement with all proposed sectors* – despite best efforts to invite stakeholders from all sectors, there was unfortunately limited engagement with the Defence, Aerospace and Security, and Bank, Finance, and Insurance Sectors. However, this presents a future opportunity for the EO Hub, to engage further with these sectors to determine whether EO can provide relevant solutions.

8. PRIORITIES FOR QUEENSLAND EO

Growing the EO sector in Queensland requires a strategic approach that involves collaboration among various stakeholders, investment in technology and infrastructure, fostering innovation, and promoting partnerships. Potential future opportunities were validated by the stakeholder group, and prioritised, this prioritisation is outline in Figure 19. Greater engagement with end users was highlighted, as was addressing challenges with data interoperability, standardisation, fusion, and interoperability.

Figure 19 - Prioritisation of recommendations from workshop participants

Based on the market analysis, the following activities have been identified as priorities for the Queensland Earth Observation Community:

Data Accessibility and Open Data Initiatives: Promote open data policies to facilitate the sharing of Earth Observation data among researchers, businesses, and the public. Encouraging data accessibility and uptake of FAIR principles can spur innovation and create opportunities for new applications and services.

Education and Training: Foster a skilled workforce by investing in education and training programs related to Earth Observation technologies and data analysis. Collaborate with universities and research institutions, as well as consulting with industry to understand their workforce needs, to develop specialized courses and workshops that cater to the needs of the relevant sector.

Supporting Startups and SMEs: Support initiatives that encourage startups and small to medium-sized enterprises (SMEs) to grow in the Earth observation industry. These companies often bring fresh ideas and innovations to the sector and can contribute to its growth. Initiatives could include providing access to customers, assisting with data licensing, and attracting investment.

Industry-Academia Collaboration: Facilitate partnerships between the EO industry and academia and develop collaborative research projects that will help solve real-world challenges and promote the development of cutting-edge technologies, while helping Queensland industry to grow its capacity and impact.

Public Awareness and Outreach: Raise awareness about the importance of EO and its applications in various sectors like agriculture, environmental monitoring, disaster management, urban planning, etc. This can garner public and government support for further investment. This can be enhanced through collaborating with existing initiatives such as EOA and JRSRC.

National and International Engagement: Engage nationally, with other states and internationally to share knowledge, expertise, and data. Collaborative efforts can lead to a more comprehensive understanding of global issues and provide opportunities for Queensland industry to participate in national and international EO initiatives.

Policy and Regulatory Support: Develop supportive policies and regulations that encourage the growth of the Earth observation sector while ensuring ethical use of data and adherence to privacy standards.

Promoting Commercial Applications: Explore and support commercial applications of Earth Observation data, such as in the agriculture, mining, forestry, and tourism industries. Demonstrating the value of Earth Observation data in these sectors can attract private investment.

Showcasing Success Stories: Highlight successful case studies, including products and projects, that have utilized Earth Observation data to bring about positive impacts in various fields. This can inspire others to adopt similar approaches and demonstrate the sector's potential.

Investment in Earth Observation Infrastructure: Encourage the government and private sector to invest in satellite technology, ground-based monitoring stations, and other essential infrastructure to enhance the capabilities of Earth Observation in the region. This could include establishing data processing facilities, and ground stations.

By implementing these measures, Queensland can create an enabling environment for the growth of the Earth Observation sector, fostering innovation, economic development, and sustainable solutions to both local and global challenges.

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APPENDIX I – ENGAGEMENT DETAILS

Survey

An online survey was created to engage with audiences broadly across Queensland and consisted of a combination of multiple-choice and open response questions. The key goals of the survey were to:

- Understand where on the downstream EO value chain participants are, what sorts of organisations (size, sector, industry/research/gov);
- Understand how they currently use EO and what how this will change in next 2-5 years;
- Understand what EO-related challenges and opportunities participants face, both (1) now and (2) in the next 2-5 years;
- Understand what support their business would need in coming 2-5 years;
- Understand what community building would benefit participants in Queensland;
- Understand where they see the role of the EO Hub to unlock Qld's EO market moving forward.

The survey was directly shared with members of the stakeholder list compiled during the initial phase of this research. In addition, the survey was distributed via several social media channels, including LinkedIn and Twitter. The survey was further distributed directly to organisations where a named contact was not available, e.g., Winyama.

The survey was completed by 59 people in the time it was open, from June 21 – July 19, 2023. Of these responses, 18 were only partially completed, and insights from these responses were utilised where possible.

Interviews

To further deepen our understanding of the EO Market and Community in Queensland, we undertook qualitative research in the form of targeted interviews with key members of the QLD EO community. These interviews were all delivered online, averaging 40 minutes in duration, and the participants identity has been protected to ensure their anonymity. The interview process took each participant through a series of predefined questions, with the goal to understand from individuals across the downstream EO value chain, and across various sectors (in industry, government, and research):

- How EO currently fits into the way their organisation does business;
- What they think holds EO back in Queensland;
- What they see as the biggest opportunities for lucrative future growth and improvement for the QLD EO Market;
- What would help their organisation in realizing its 5-year plan and taking advantage of these transformative changes;
- What support they feel the QLD Earth Observation ecosystem needs to drive widescale improvement and growth over the next 2-5 years;
- What role they think the Qld EO Hub should take in facilitating these changes;
- How could the Qld EO Hub best do this.

Interview participants were also encouraged to share suggestions and recommendations for how the sector can be improved.

A total of 24 interviews were conducted. Each online interview was recorded, digitally transcribed using Otter.ai, and manually proofread for accuracy. These corrected transcripts were then coded using a qualitative coding research tool, Delve.

Qualitative coding is a method for the systematic categorization of excerpts in qualitative data, with the objective to identify common themes and patterns, and the approach enable further analysis of these themes and patterns. Coding qualitative data makes the analysis more systematic and rigorous, whilst providing transparency and reflexivity. This market study adopted several types of qualitative coding; Inductive, Deductive, and In Vivo. An overview of these and the qualitative codes used is available in Appendix II – Qualitative Coding Methodology.

Workshop

Two workshops were held on Wednesday, July 19, 2023, in Brisbane. The first of these workshops was held face-to-face in Brisbane CBD, and the second held online to those who were not able to attend the first workshop due to geography or other commitments. The purpose of these workshops was to:

- Present and discuss preliminary findings from survey and interview industry engagement with those in the room
- Gain a deeper understanding of what participants feel the Queensland Earth Observation sector can achieve and what opportunities there are to help create the best future for it
- Support the Queensland Earth Observation sector coming together to build community

Both workshops followed the same structure:

- An overview of the Queensland Earth Observation Hub
- An overview of the purpose and methods of this Market Study
- Activity 1: an interactive SWOT analysis of the Queensland EO community from everyone in the room, conducted via Mentimeter
- A detailed overview of key findings from the market study, within the context of the SWOT analysis conducted in Activity 1
- Activity 2: framing powerful questions to help address the top three ranked challenges from the market study's key findings by sector and value chain groups
- Report-back and workshop close.

A total of 24 participants attended the face-to-face workshop, and 3 participants attended the virtual workshop.

APPENDIX II – QUALITATIVE CODING METHODOLOGY

Three approaches to coding were used in this methodology:

- *Deductive*: 'Top-down coding' - Deductive coding is a top-down approach where the codebook is developed using an initial set of codes. These codes were based on the key research questions that this study aimed to address. This approach was suitable as the study aimed to address several key themes and allows for the coding of interviews to be directly categorised to these themes.
- *Inductive*: 'Ground up coding' - Inductive coding is a ground-up approach where codes are derived from the data. Codes are not predefined at this stage and instead the transcripts are first reviewed to allow the narrative or theory to emerge from the raw data itself. This is great for exploratory research or times when you want to come up with a new theories, ideas, or concepts.
- *In Vivo*: 'Using the participant's own words' - For In Vivo coding, coding is applied to an excerpt based on a participant's own words, and not the interpretation of the researcher. This allows the participant's own spoken language to be utilised, to preserve their intent and meaning. In Vivo coding is often used as a first step to summarize passages into single words or phrases extracted from the interview itself.

QUALITATIVE CODE	DESCRIPTION	
Use of EO	Current use of EO	
	Future use of EO	
Threats	What are the current threats to the Qld EO market?	
Opportunities	Partnerships and collaborations	International Relations
	Developing current operations/capabilities	
	Needs and ideas (future)	Strategy
		Data ethics
		Funding
		Education
		Success
		Data interoperability & harmonisation
		Data access
	Future proofing the industry	
	Gaps	
Weaknesses	What are the weaknesses of the Qld EO Market?	
Strengths of EO Market	What are the current strengths of the EO Market?	

APPENDIX III – DETAILED RESULTS BY SECTOR

Appendix III provides supplementary results extracted by sector.

I. Agriculture, Fisheries and Forestry

Stakeholder Value Chain Distribution

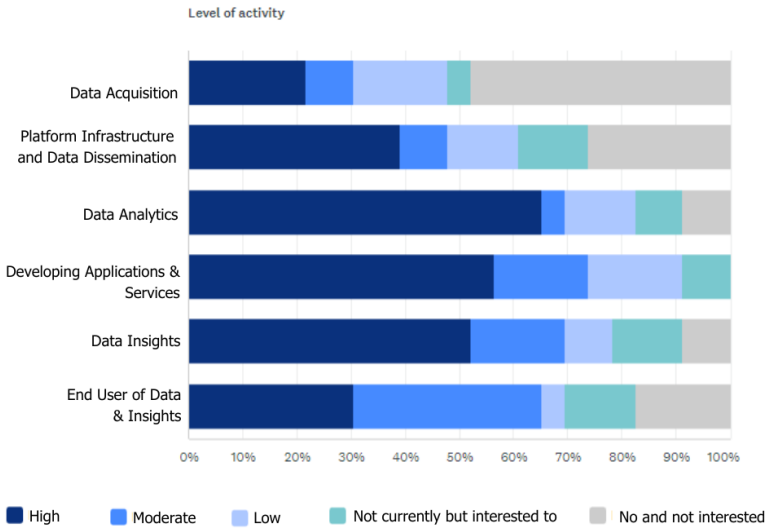

Figure 20 - Current EO Value Chain participation in Agriculture, Fisheries and Forestry.

Developing applications and services had the highest overall use of EO while data acquisition had the lowest. The disparity between data acquisition and parts of the value chain that provide products and services highlights the current climate of the QLD EO sector where there is insufficient access to EO data within QLD. Potential growth into EO is seen across all parts of the value chain, with the greatest being in platform infrastructure and data dissemination, data insights and end user of data and insights. This follows the growing interest in EO as a product for information gathering and decision-making as well as the need for developed infrastructure to support the future increased use of EO. This is further shown by the few responders in developing applications and services currently not using EO to any extent stating their interest in expanding into EO use.

Current & Projected use of EO

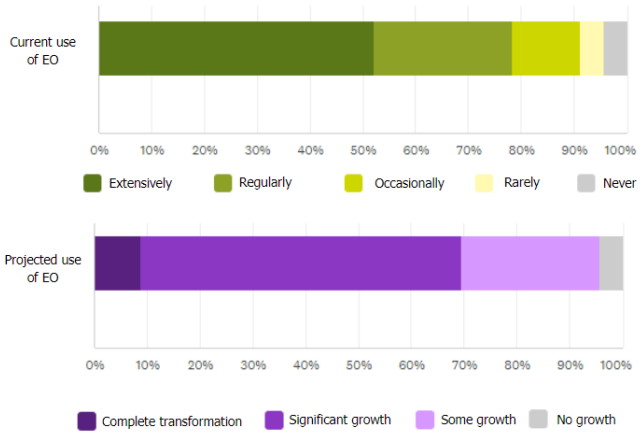

Figure 21 - Current and projected use of EO in Agriculture, Fisheries and Forestry.

The current use of EO to any extent shown in Figure 21 indicates the importance EO has for this sector and the projected use of EO indicates that EO will only grow in importance both as a product and as a resource to the sector.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Agriculture, Fisheries and Forestry.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - A standardised approach to crop mapping, land management & biodiversity
  - AI to detect specific invasive species at a specific date / time
  - AgTech
  - Coordination of research, development, funding, commercialisation to solve real world problems.
  - Data simulation in realistic environments (digital twins)
  - Multiscale environmental monitoring. cultural heritage & ESG
- **2-5 years**
  - Biomass mapping
  - Modelling risk (invasive species, biodiversity, climate change)
  - Environmental temporal analyses including up to date tracking (Real-time)
  - Increased processing capabilities include GPU HPC infrastructure for large time series data sets.
  - Greater access to analysis ready data cubes for custom model development and applications.
  - Monitoring drivers of forest fires including drought, monitoring crop phenology to predict yields, and monitoring water quality to predict/prevent algal blooms.
  - Australia is remote and needs to consider greater opportunities in emerging regions such as Pacific, Africa and South America. EO Companies have great capabilities and need to look into how they can scale and take their technologies internationally.

Challenges

- Public understanding and awareness of EO technology and capabilities.
- Access to affordable high-resolution imagery that is current and frequently captured.
- Attraction and retention of suitably skilled people (EO, data science, computing, physics, ecology)
- Competition from Government – A challenge to growing the EO industry is government agencies developing and providing EO sector- and industry-specific value-add services, in particular directly to other government agencies (to whom they have easier access in the first place).
- Lack of awareness of private sector capabilities across Federal, State, Universities and CSIRO, and lack of collaboration

- Uncoordinated and underfunded approach to land use and land cover mapping and change analysis.

What we heard: EO Community, Support & Enabling Services Needs

Below is a selection of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Agriculture, Fisheries and Forestry sector.

Gaps & opportunities in the provision of support and enabling services

- Opportunity for improved focus on an EO hub / ecosystem to coordinate and maximise the existing QLD market would help. Attracting investment through demonstrating a cohesion and a common strategy... making QLD a centre for EO excellence to attract funding, R&D and investment
- How the government works with private industry
- Focus on commercialisation
- R&D funding, enabling business opportunities, advocacy, driving investment.
- Clear examples or use cases where data products can be used, and low barriers to use.
- Start-up and small EO companies had more opportunities to communicate directly with end user (state and regional) government agencies
- End user connection to research, industry and government solutions is a big opportunity

II. Environment and Climate (inc. Biodiversity, Ecosystems and Natural Capital)

This sector uses EO extensively and this will continue to grow as the projected growth indicates a large portion of organisations will see growth in their use of EO, continuing to support the growth trends of EO as a viable product and sector for investment.

Stakeholder Value Chain Distribution

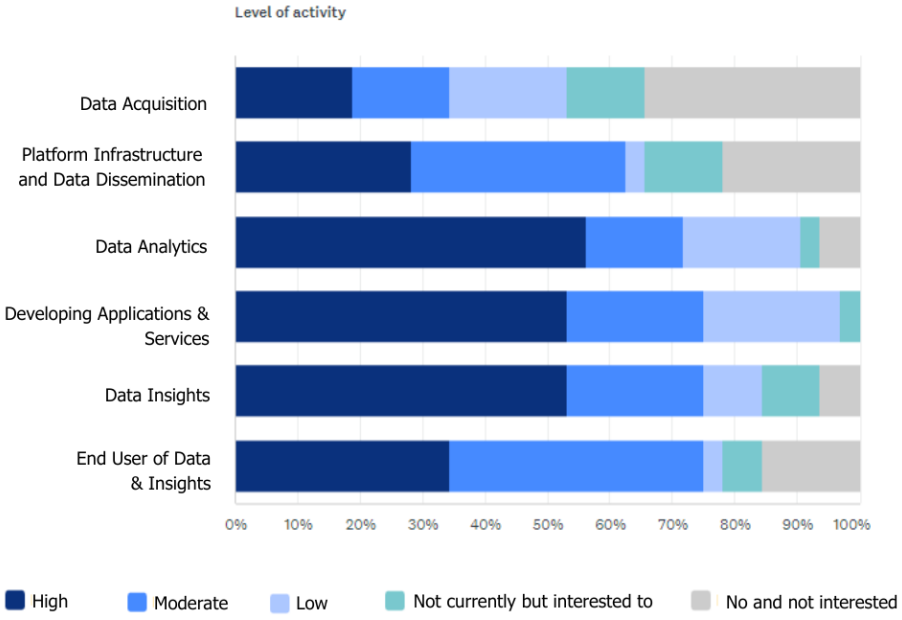

Figure 22 - Current EO Value Chain participation in Environment and Climate.

Developing applications and services had the highest overall usage of EO and data acquisition had the lowest overall EO use. The disparity between data acquisition and parts of the value chain that provide products and services highlights the current climate of the QLD EO sector where there is insufficient access to EO data within QLD. Potential growth into EO is highest in data acquisition and platform infrastructure and data dissemination. This growth will aid in the current disparity and potentially lead to greater growth and developments in other areas of the value chain as EO data acquisition and infrastructure improves.

The planned growth in platform infrastructure and data dissemination as well as all organisations in developing applications and services are either currently using EO to some extent or plan to highlights the growing interest in EO as a product or service and the need for developed infrastructure. The number of organisations that use EO to a high extent across data analytics, developing applications and services, and data insights in this sector indicates that the levels of data available within QLD is not enough to keep these organisations looking purely within QLD and they may require to outsource data acquisition to international vendors.

Current & Projected use of EO

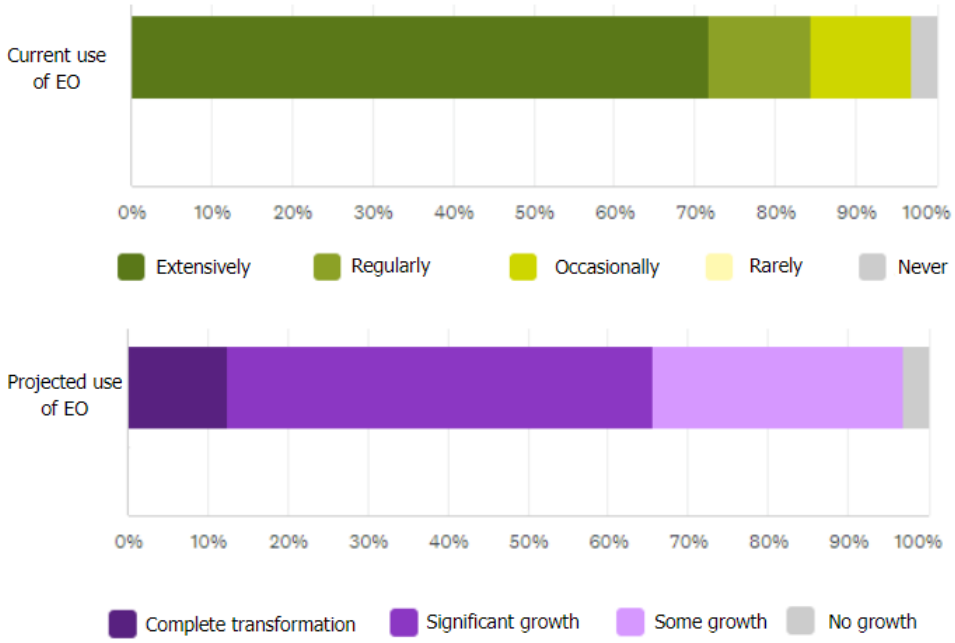

Figure 23 - Current and projected use of EO in Environment and Climate.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Environment and Climate.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Supporting emerging policy in natural capital/climate change
  - Use of EO data to assist with Restoration of native forest, State of Environment reporting (condition assessment) of natural areas, Risk assessment for bushfire and security of adjacent infrastructure and government assets.
  - Land management & Biodiversity
  - AI to detect specific invasive species at a specific date / time (eg locust swarms) Information to support modelling invasive species risk, especially invasive species impacts (on agriculture, environment, health, amenity)
  - Data simulation in realistic environments via digital twins
  - Land changes and flood monitoring
- **2-5 years**

- SLATS and bio-condition mapping advancements from the government science sector that are focussing on development needs of industry.
- Biomass mapping
- Rapid assessment of fire risk, and bio-condition of native forests.
- Facilitating temporal analyses including up to date tracking
- Increased processing capabilities include GPU HPC infrastructure for large time series data sets. Greater access to analysis ready data cubes for custom model development and applications.
- Climate/disaster preparedness
- Developing new satellites and technologies to monitor the drivers of climate change, as well as monitoring specific aspects of agriculture and water quality.
- Global emphasis on ESG and Natural Capital reporting etc

Challenges

- **Right Now**
  - Availability of high-resolution data products on vegetation cover
  - Training in EO techniques and technologies for varying stakeholders of the natural environment on public and private lands.
  - Skills and knowledge in EO
  - Lack of government sharing knowledge about reasons for vegetation management and the positive impact that policies that protect natural assets such as vegetation and biodiversity and cultural sites can have on production and market access for Queensland industry.
  - Government and Research institutions trying to replicate what is already available in the market.
- **2-5 years**
  - Inconsistent definitions of what is intact what is not (eg deforestation defintions) when it comes to utilising the data available, its more the method than the technology that are holding back our ability to accurately monitor and measure modern human impact and to model future trends that will affect the economy, value of life and survival of industry and populations living in already challenging environments.
  - Cost-effective unrestricted licensing for satellite imagery would rapidly grow demand as the aerial imagery market is saturated and ATC restrictions are only getting worse.
  - Connecting expertise in EO data acquisition and EO analytics with local government agencies to enable rapid assessment and monitoring applications for natural areas for management.

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of “quotes” gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Environment and Climate sector.

Gaps & opportunities in the provision of support and enabling services

- Growing and accessing a skilled workforce and skills development in existing workforce
- Understanding of significance of EO analytics.
- The open-source community
- More frequent networking between government, research and industry partners working with EO data to gain better understanding of current possibilities and challenges each sector experiences. Queensland has a rich research focus in EO (QUT, UQ) but slow uptake in government.

- Start-up and small EO companies had more opportunities to communicate directly with end user (state and regional) government agencies.
- Building networks connecting local government with current research and development. Local government has a wide range of expertise and a pressing need to apply EO data analytics to inform decision making tools that can assist with management.
- EOA is in a good position to support stakeholders

II. Infrastructure, Planning and Construction (including Transport)

Infrastructure, planning, and construction has the potential to be one of the biggest influences in the future development of the QLD EO community due to how extensively EO is used within the sector and that all associated organisations expect to see some level of growth of EO use.

Stakeholder Value Chain Distribution

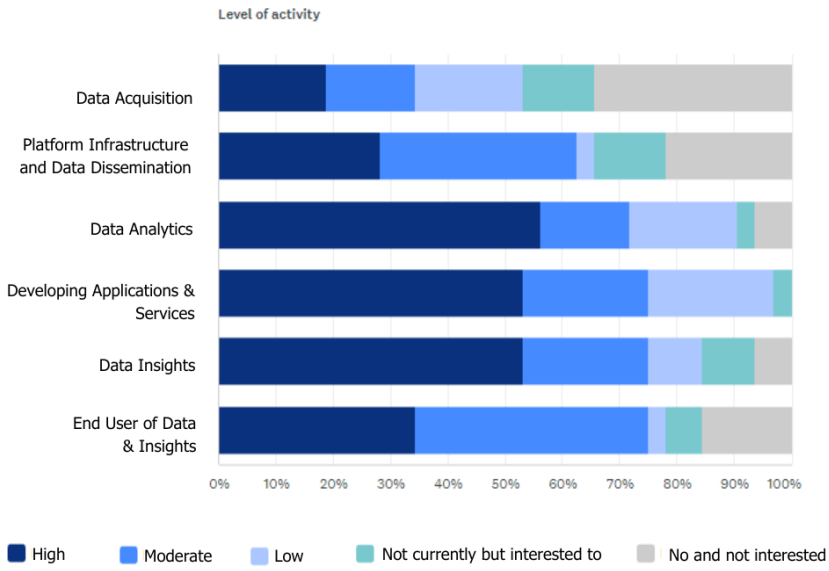

Figure 24 - Current EO Value Chain participation in Infrastructure, Planning and Construction (inc. Transport).

Developing applications and services has the highest overall EO usage while data acquisition has the lowest. The disparity between data acquisition and parts of the value chain that provide products and services highlights the current climate of the QLD EO sector where there is insufficient access to EO data within QLD. Data acquisition and platform infrastructure and data dissemination have the highest potential of growth. This growth will aid in the current disparity and potentially lead to greater growth and developments in other areas of the value chain as EO data acquisition and infrastructure improves. The planned growth in platform infrastructure and data dissemination as well as all organisations in developing applications and services are either currently using EO to some extent or plan to highlights the growing interest in EO as a product or service and the need for developed infrastructure.

Current & Projected use of EO

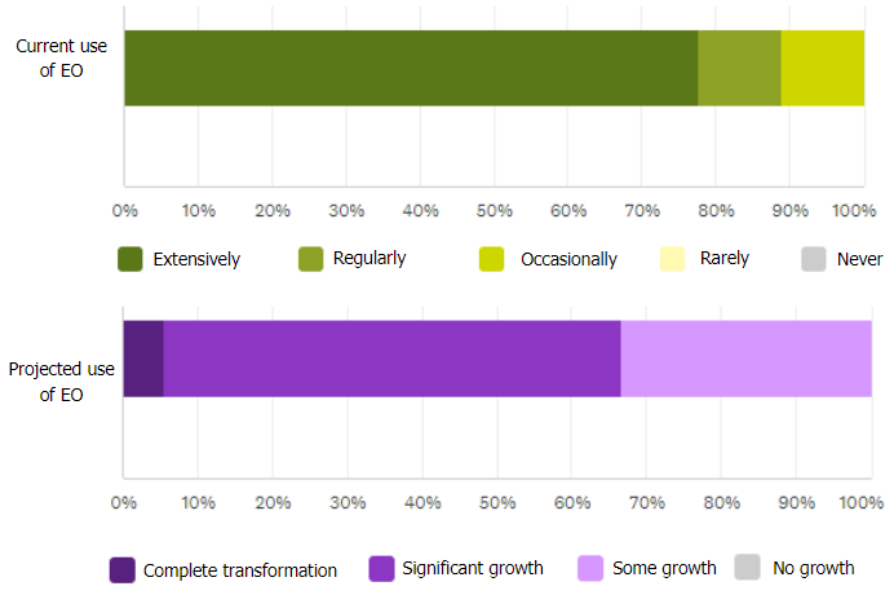

Figure 25 - Current and projected use of EO in Infrastructure, Planning and Construction (inc. Transport).

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Infrastructure, Planning and Construction.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Risk assessment for bushfire and security of adjacent infrastructure and government assets.
  - I think the reliance on digital twins for data-driven decisions will see significant growth.
  - Using EO technology to derive business intelligence, and to focus planning priorities.
  - Timely (potentially daily) intelligence (not just product delivery) to support business priorities such as Disaster Management, Community support and enhancement opportunities.
- **2-5 years**
  - Significant uptake in use, particularly by those outside the remote sensing/ GIS sector has increased the awareness and demand for EO data across engineering, planning and construction
  - climate/disaster preparedness
  - Global emphasis on ESG and Natural Capital reporting etc
  - Digital Twins (complementing BIM, 3D data)

Challenges

- Data sharing. Data that we acquire has many use cases but is often used by a singular entity. We need to break silo's/barriers to get companies and government departments working together.
- Support from government for joint user facilities, the equipment to enable EO requires high CAPEX which limits SME engagement
- Data resolution and accuracy.
- Restricted licensing

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Infrastructure, Planning and Construction sector.

Gaps & opportunities in the provision of support and enabling services

- Connecting expertise in EO data acquisition and EO analytics with local government agencies to enable rapid assessment and monitoring applications for natural areas for management.
- Engineering companies (end users)
- Sector findings aligned with common findings

III. Utilities and Telecommunications

Stakeholder Value Chain Distribution

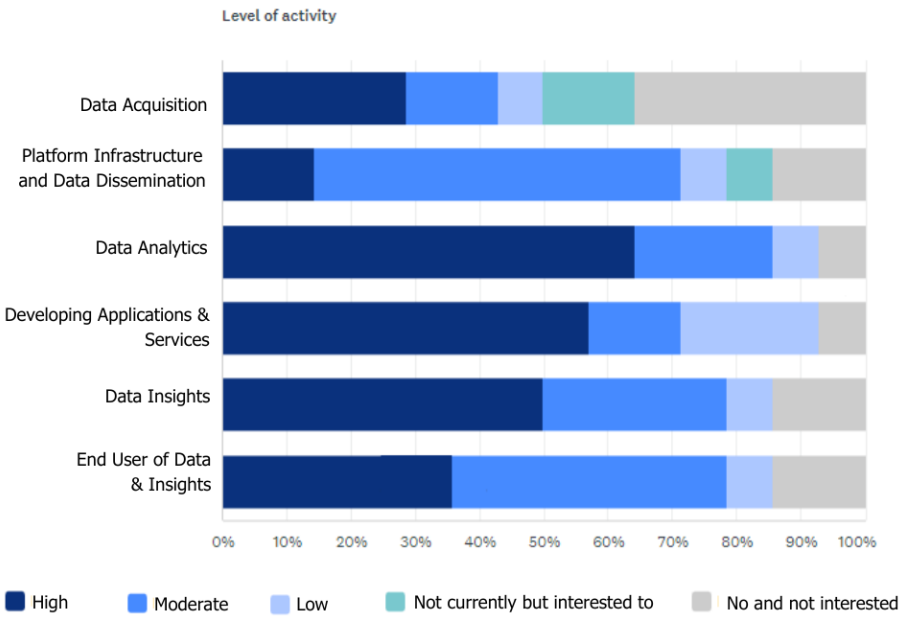

Figure 26 - Current EO Value Chain participation in Utilities and Telecommunication

Current & Projected use of EO

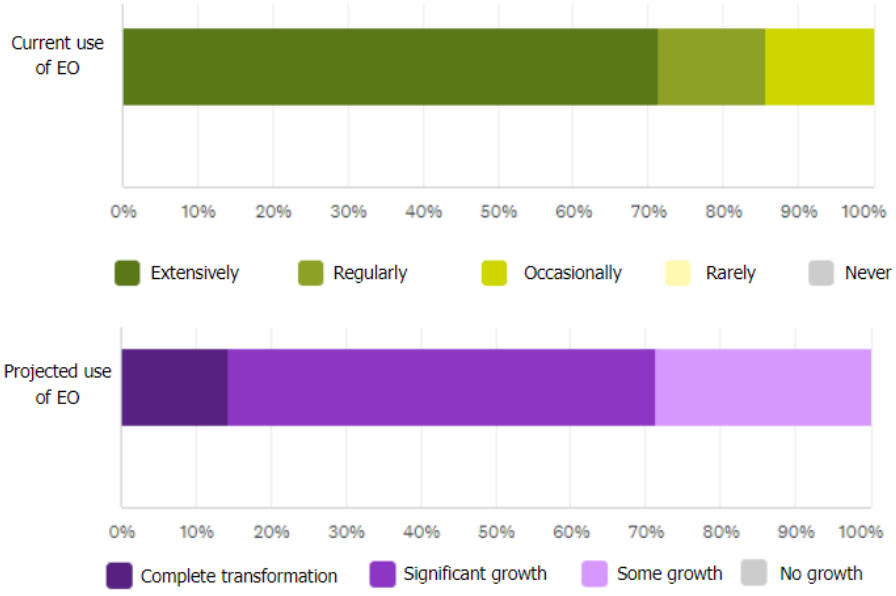

Figure 27 - Current and projected use of EO in Utilities and Telecommunication.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Utilities and Telecommunications.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Disaster response could be one of the largest areas.
  - I think the reliance on digital twins for data-driven decisions will see significant growth.
  - Real-time collection and delivery of data and improved data resolution – supporting operational activities such as vegetation management
- **2-5 years**
  - Working collaboratively (providers & users) to apply rapidly improving data analytical capabilities to build local capabilities and outcomes that can then be applied and sold internationally.
  - Disaster preparedness
  - Visibility of consumer storage, demand and generation is becoming critical, as well as Electric vehicle location and network and social impact.

Challenges

- Data Sharing – across industry, and with government
- Ability to easily combine EO Products into inhouse spatial systems - by lay users, not just GIS professionals.
- Awareness in senior govt and commercial sectors
- Defining business cases and funding justifications to support EO technology and data creation/capture and use. Historically, data is not considered a capitalised asset.

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Utilities and Telecommunications sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings

IV. Banking, Finance, and Insurance

Stakeholder Value Chain Distribution

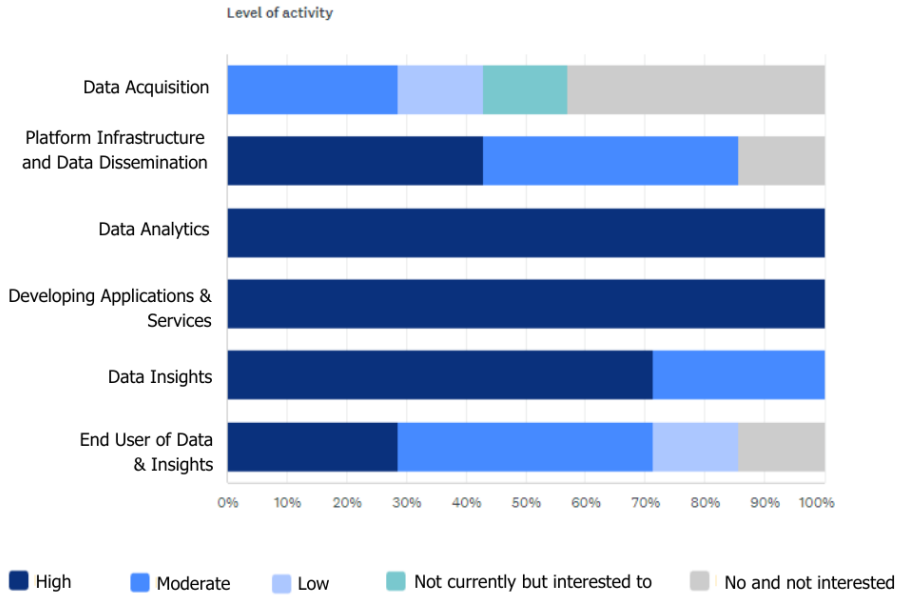

Figure 28 - Current EO Value Chain participation in Banking, Finance & Insurance.

Current & Projected use of EO

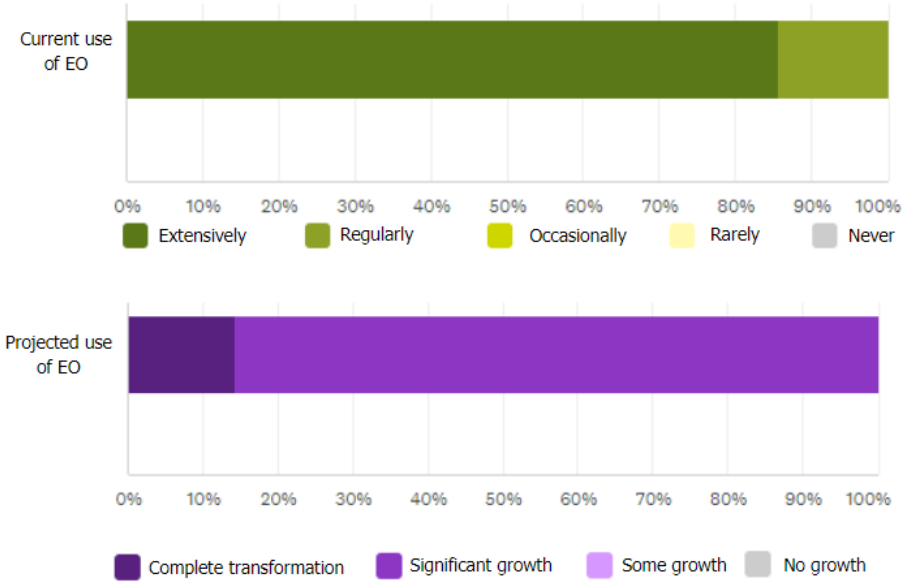

Figure 29 - Current and projected use of EO in Banking, Finance & Insurance.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Banking, Finance, and Insurance.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Growing demand related to risk management, disaster response / recovery.
  - Climate risk and impact
  - Land Management & flooding
- **2-5 years**
  - Climate / disaster preparedness
  - Global emphasis on ESG and Natural Capital reporting etc

Challenges

- focus on national consistency in data and reporting
- data, especially socio economic and industry tends to be poorly linked

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Banking, Finance, and Insurance sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings

V. Mining and Energy Resources

Stakeholder Value Chain Distribution

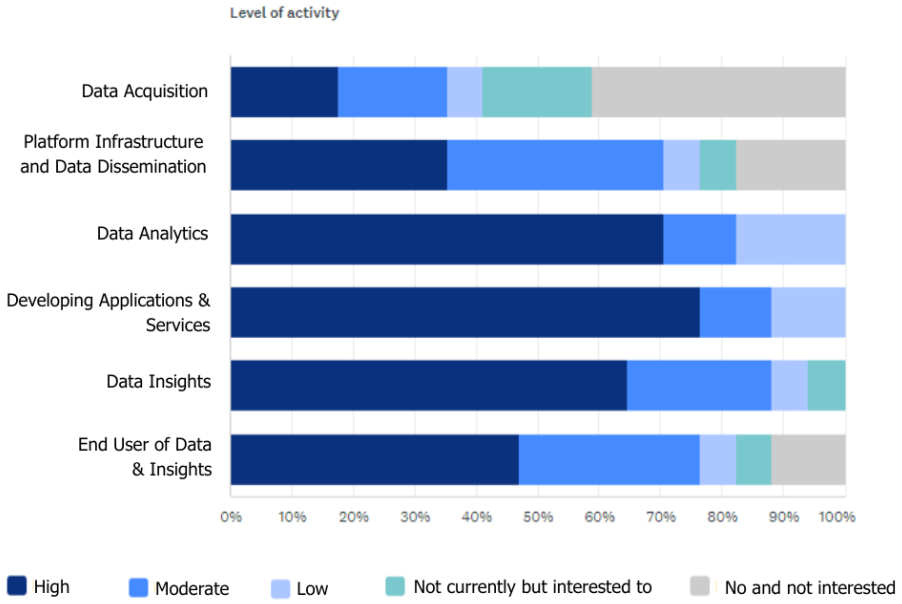

Figure 30 - Current EO Value Chain participation in Mining and Energy Resources.

Current & Projected use of EO

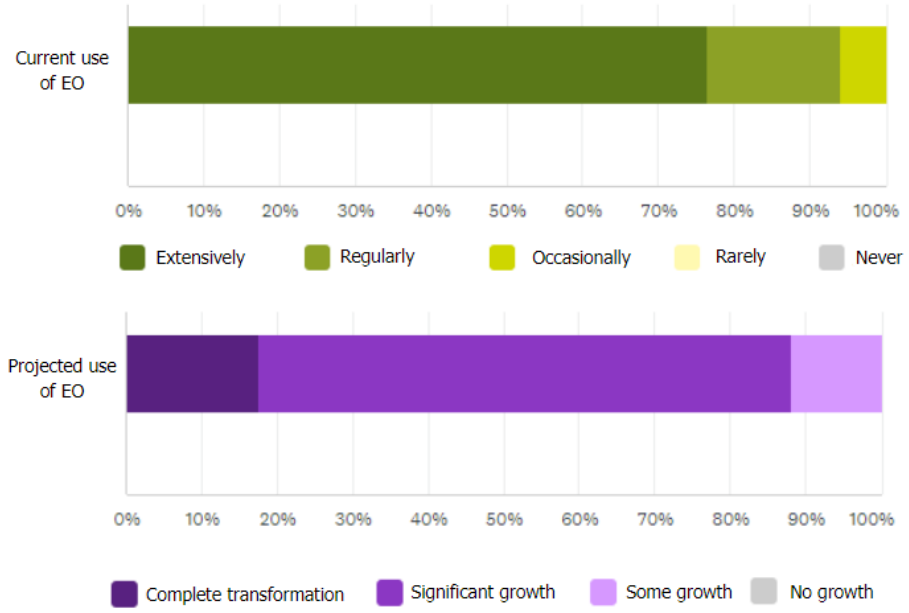

Figure 31 - Current and projected use of EO in Mining and Energy Resources.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Mining and Energy Resources.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Disaster response could be one of the largest areas.
  - Reliance on digital twins for data-driven decisions will see significant growth.
  - Hyperspectral for critical minerals
  - Link this initiative to QLD Governments critical minerals strategy. Use EO to accelerate exploration and discovery of critical minerals deposits. Also use EO data to help facilitate community consultation and engagement for approvals of new mining projects - specifically critical minerals. Use EO data to help facilitate a conversation about how critical minerals are "critical" to support reduction of carbon emissions.
  - Multiscale environmental monitoring. cultural heritage & ESG
  - Environmental monitoring for regulatory compliance and reporting
- **2-5 years**
  - Visibility of consumer storage, demand and generation is becoming critical, as well as Electric vehicle location and network and social impact.
  - Climate/disaster preparedness
  - Global emphasis on ESG and Natural Capital reporting etc

Challenges

- The Queensland Globe product competes with private EO companies in the mining industry and is supplied for free. Miners have the means and get commercial gain from this service so why shouldn't they contribute to the local EO economy.
- Big mining companies have dedicated investments in EO capabilities, while smaller mining and exploration companies are being left behind

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Mining and Energy Resources sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings.

VI. Health, Public Safety and Emergency Management (inc. Humanitarian Aid)

Stakeholder Value Chain Distribution

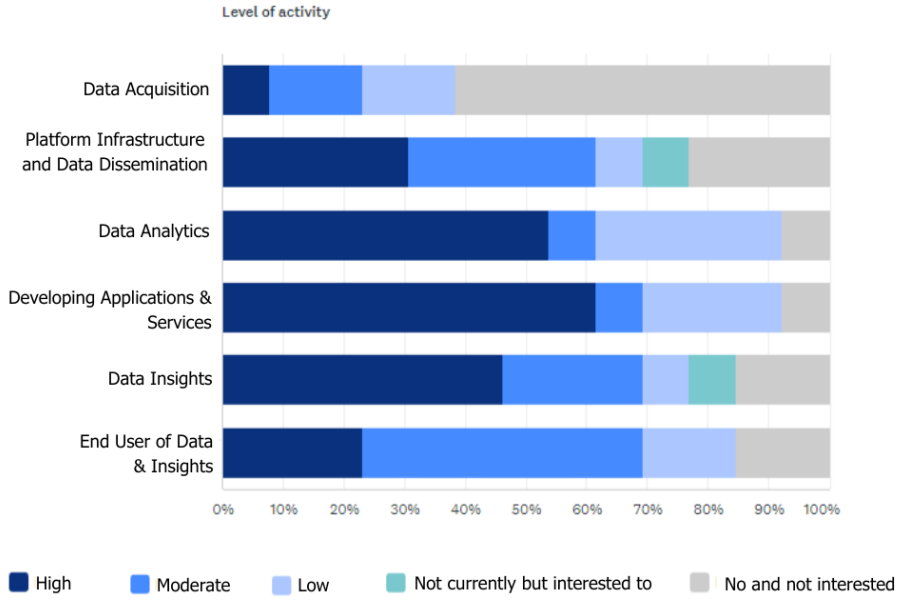

Figure 32 - Current EO Value Chain participation in Health, Public Safety and Emergency Management.

Current & Projected use of EO

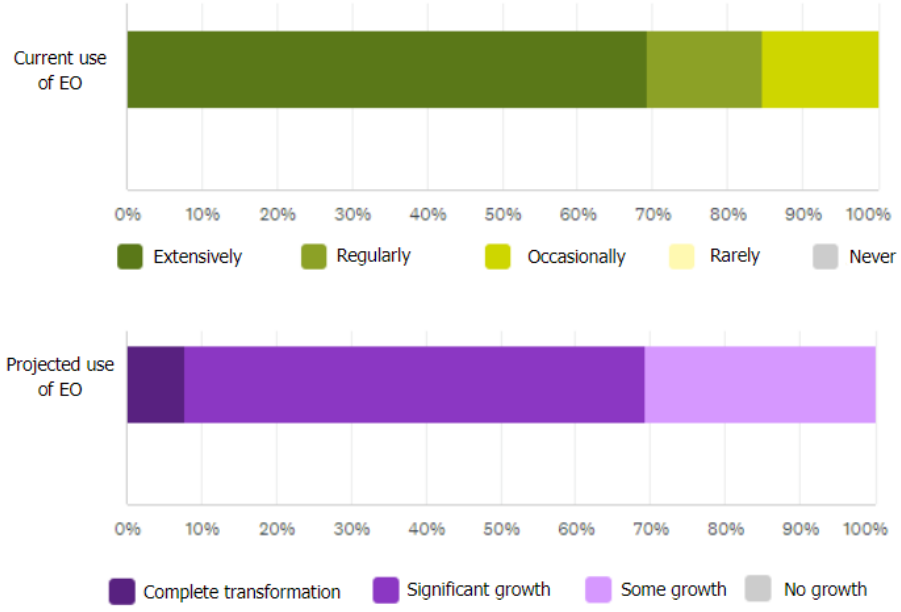

Figure 33 - Current and projected use of EO in Health, Public Safety and Emergency Management.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Health, Public Safety and Emergency Management.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Climate/disaster preparedness
  - More frequent capture of high-resolution aerial, satellite and drone imagery and LiDAR data.
  - Vegetation and water management. Climate change impacts analysis on temperature and community health
  - Timely (potentially daily) intelligence (not just product delivery) to support business priorities such as Disaster Management, Community support and enhancement opportunities.
  - Land Management and Flooding
- **2-5 years**
  - Launch of dedicated Australian satellites to provide timely emergency response data

Challenges

- Overly commercial nature of industry limits the availability of data for public good applications
- Ability to easily combine EO Products into inhouse spatial systems - by lay users, not just GIS professionals.

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Health, Public Safety and Emergency Management sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings

VII. Defence, Security & Aerospace

Stakeholder Value Chain Distribution

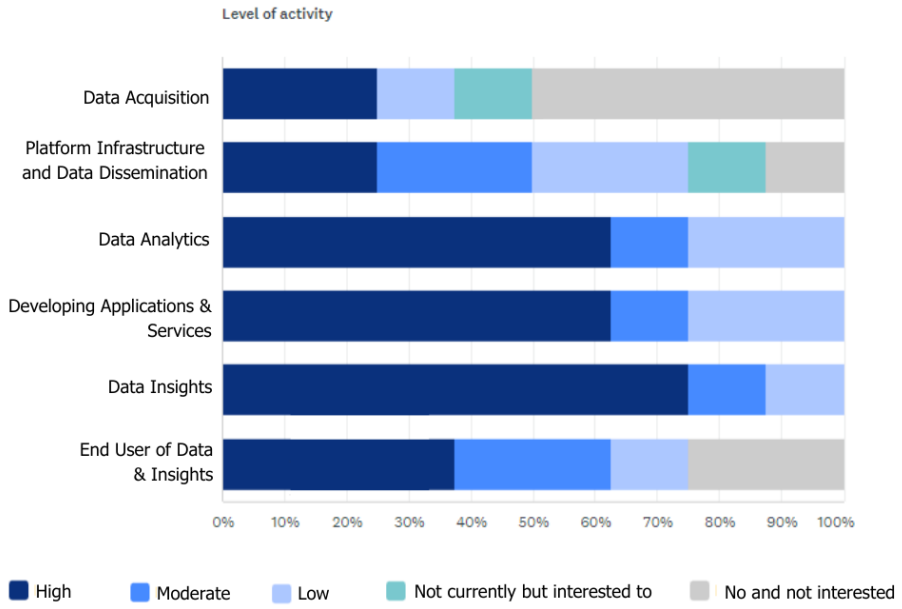

Figure 34 - Current EO Value Chain participation in Defence, Security and Aerospace.

Current & Projected use of EO

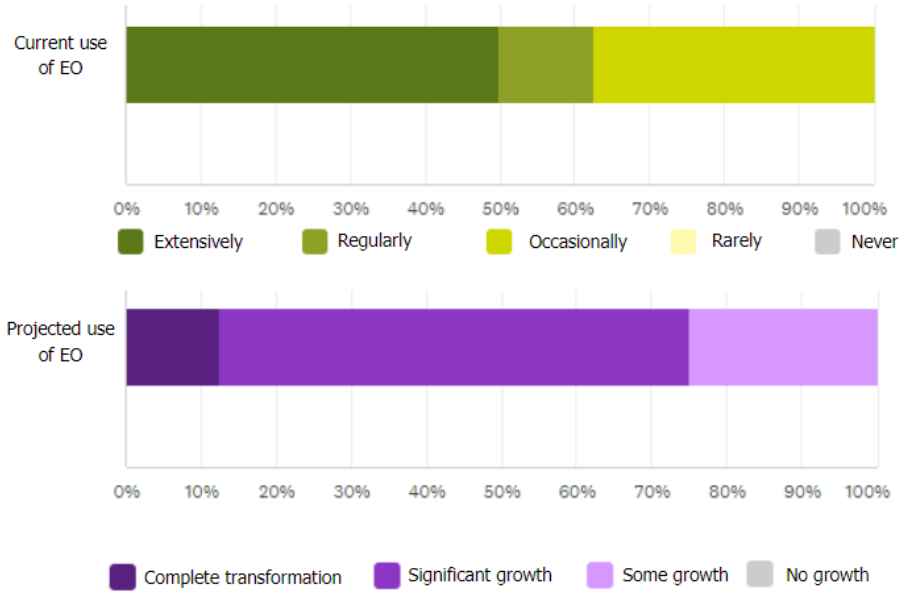

Figure 35 - Current and projected use of EO in Defence, Security and Aerospace.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Defence, Security & Aerospace.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Ground Stations - Antennas
  - Data centres - MS and AWS all seem to be in southern states
  - Satellite manufacture
  - Analytics Industry led solutions e.g., maritime domain awareness, mining, emergency response. Scaling into international markets.
  - For the sector: launch operations, sensor development, supporting international EO launches with cal/val
  - Assuring data streams
- **2-5 years**
  - Launch of new Australian satelites
  - Australia focused multispectral satellites with higher spatial and temporal resolutions and better coverage.

Challenges

- Generally, the private sector does not consider how it can scale outside of Australia. Australia is remote and needs to consider greater opportunities in emerging regions such as Pacific, Africa and South America. EO Companies have great capabilities and need to look into how they can scale and take their technologies internationally.
- Companies in Queensland are too small to compete with national and international players, particularly for defence contracts
- Underdeveloped Australian space industry leading to reliance of foreign EO satellites. Uncoordinated and underfunded approach to land use and land cover mapping and change analysis.
- Australian Space Sector isn't taken seriously at a federal level - capability is decades behind the rest of the developed world, offshore resourcing is likely to continue.

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Defence, Security & Aerospace sector.

Gaps & opportunities in the provision of support and enabling services

- Opportunities to improve connections with commercial partners local to Australia and specifically Queensland. International contacts in most of the tier one EO suppliers. Government contacts in TIQ and Austrade here and overseas.
- Sector findings largely aligned with common findings

VIII. Geospatial Data and IT Services

Stakeholder Value Chain Distribution

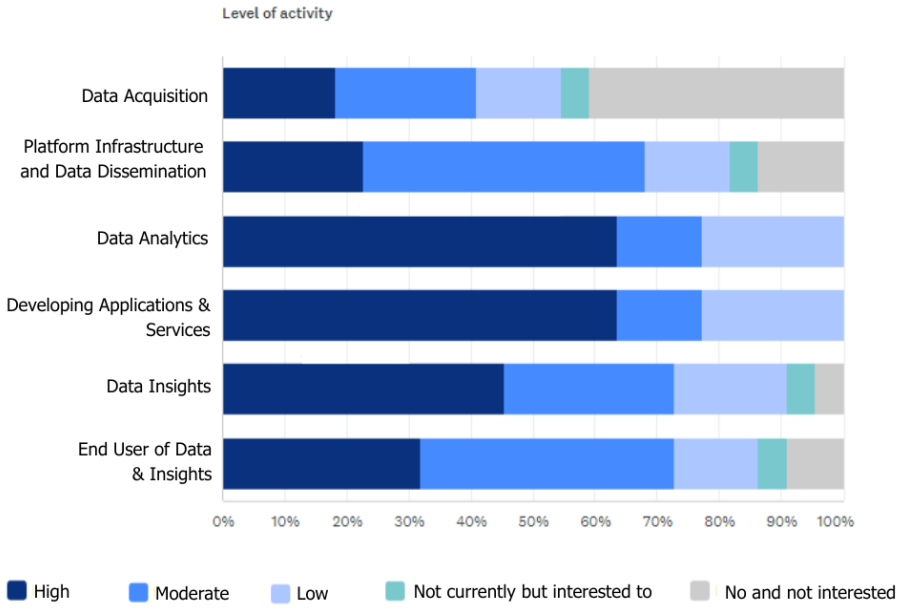

Figure 36 - Current EO Value Chain participation in Geospatial data and IT services.

Current & Projected use of EO

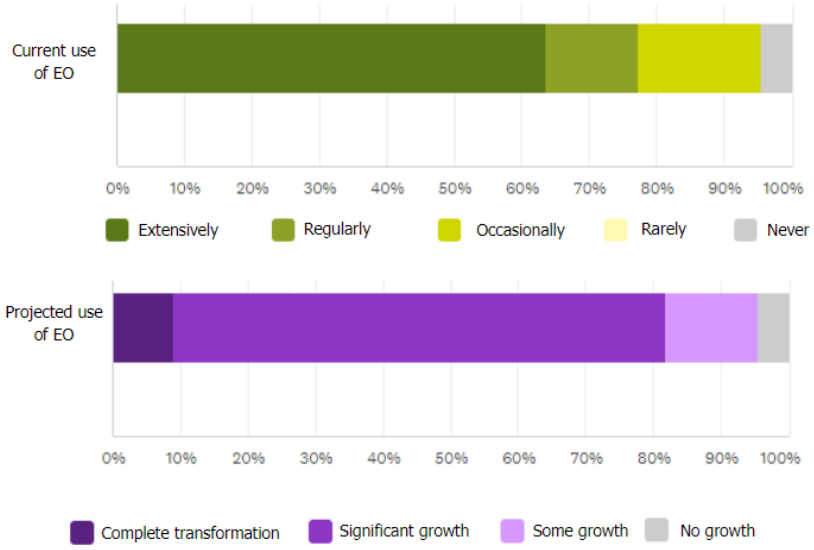

Figure 37 - Current and projected use of EO in Geospatial data and IT services.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Geospatial Data and IT Services.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Digital Twins – building hype, awareness and investment to sector
  - Increasing understanding and awareness of EO increasing opportunities
  - Technological advancements – ie. Cloud computing and storage of EO data
- **2-5 years**
  - AI making opening many opportunities, also very visible right now
  - Facilitating temporal analyses including up to date tracking

Challenges

- Sector challenges aligned with common findings

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Geospatial Data and IT Services sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings

IX. Education and Training

Stakeholder Value Chain Distribution

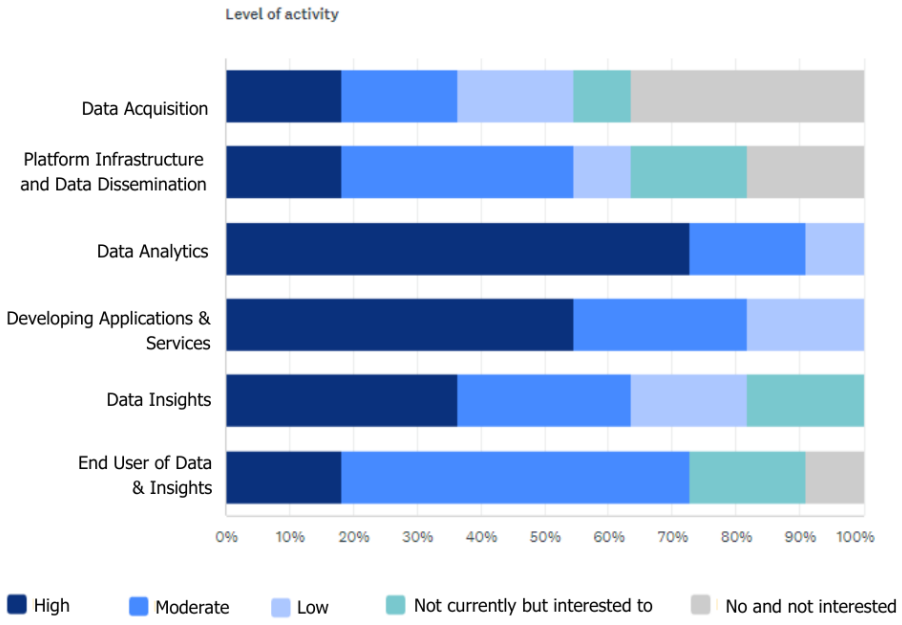

Figure 38 - Current EO Value Chain participation in Education and Training.

Current & Projected use of EO

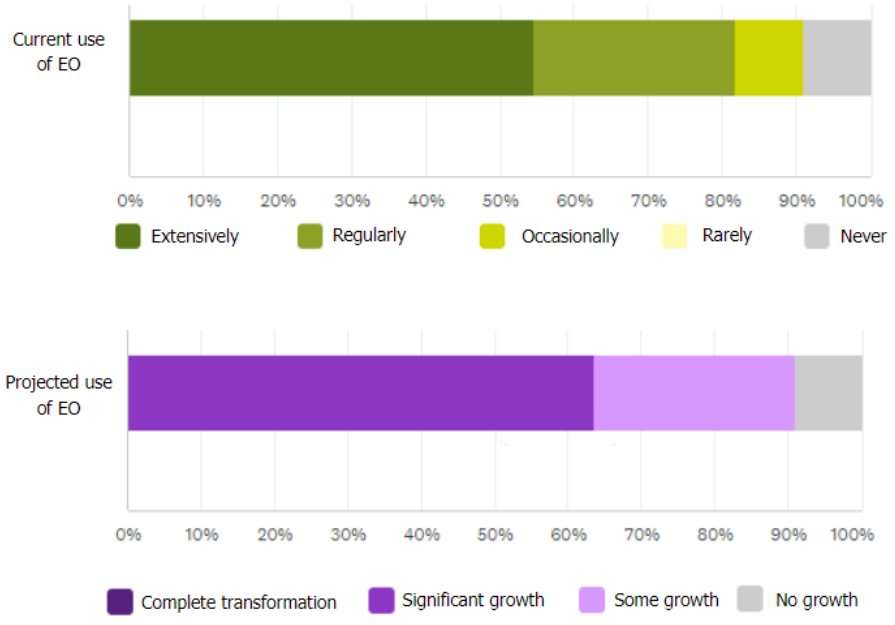

Figure 39 - Current and projected use of EO in Education and Training.

What we heard: EO Challenges & Opportunities

Below is a selection of "quotes" related to the key challenges and opportunities identified through the engagement phase specific or unique to Education and Training.

Note these statements below are opinions presented by stakeholders, giving insight into the needs of a particular sector and are not recommendations by the author.

Opportunities

- **Right Now**
  - Greater coordination of research,
  - Increased development, funding and commercialisation to solve real world problems using earth observation
  - Increased knowledge sharing amongst training organisations, support to increase training material, and the number of qualified personnel. We need more people with the relevant experience and training.
- **2-5 years**
  - Funding and investment pipeline that is connected to clear strategy linking commercial entities to R&D and either commercialisation or FAIR public provision of outcomes

Challenges

- Sector challenges aligned with common findings

What we heard: EO Community, Support & Enabling Services Needs

Below is a summary of "quotes" gathered around identified gaps and needs in community connections, support and enabling services specific or unique to the Education and Training sector.

Gaps & opportunities in the provision of support and enabling services

- Sector findings aligned with common findings

APPENDIX IV – PARTICIPATING STAKEHOLDERS

Stakeholders who participated in this market analysis through responding to the survey, partaking in an interview or attending the in-person and virtual workshops, included:

- AAM Woolpert
- AgForce
- Agtech Logistics Hub
- Alluvium
- APAC Geospatial Pty Ltd
- ARDC Planet (Australian Research Data Commons)
- Arlula
- Arup
- Australian Spatial Analytics
- Australian Agriculture Company
- BHP
- Brisbane Airport Corporation
- Brisbane City Council
- Bushfire CRC
- CAVI/CARSQ
- Central Queensland University
- CeresTag
- Cibo Labs
- Commbank
- Central Queensland University
- CSIRO
- DataFarming
- Defence Science & Technology Group
- Desert Channels Queensland
- Earth Observation Australia
- EarthCheck
- Eco-markets Australia
- Energy Queensland
- Enzen
- EPEquip
- EOMAP Australia
- ESRI Australia
- EXCI
- Flood Community of Practice/ The Water Agency/International Water Centre
- Floodmapp
- Fugro
- GBRMPA (Great Barrier Reef Marine Park Authority)
- Geoimage
- Geoscape

- Geoscience Australia
- Geospatial Intelligence
- Gilmour Space Technologies
- CO2Q
- Gold Coast City Council
- Great Barrier Reef Foundation
- Griffith University
- HERE
- IAG Firemark
- James Cook University
- Jensen Bowers
- KPMG
- LandSolution / Kurloo / Monitum
- Lockheed Martin Australia
- Meat & Livestock Australia
- Mackay Regional Council
- National Australia Bank
- NGIS
- Northrop Grumman
- Orr and Associates
- Oz Minerals
- Orbica
- Ozius
- Photomapping
- Property Council of Australia
- QinetiQ
- Queensland Department of Agriculture and Fisheries
- Queensland Department of Environment and Science
- Queensland Department of Resources
- Queensland Department of State Development, Infrastructure, Local Government & Planning
- Queensland Department of Tourism, Innovation & Sport
- Queensland Fire and Emergency Services
- Que ensland Government
- Queensland Urban Utilities
- Queensland University of Technology
- Rio Tinto
- Rohde & Schwarz
- Ruminati
- SAP
- Sat Revolution
- Sunshine Coast Regional Council
- TERN
- University of New England

- Unearthed Solutions
- The Australian National University
- University of Queensland
- University of Sri Lanka
- University of the Sunshine Coast
- Veris
- Watertech
- Wilderness Society
- Winyam

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