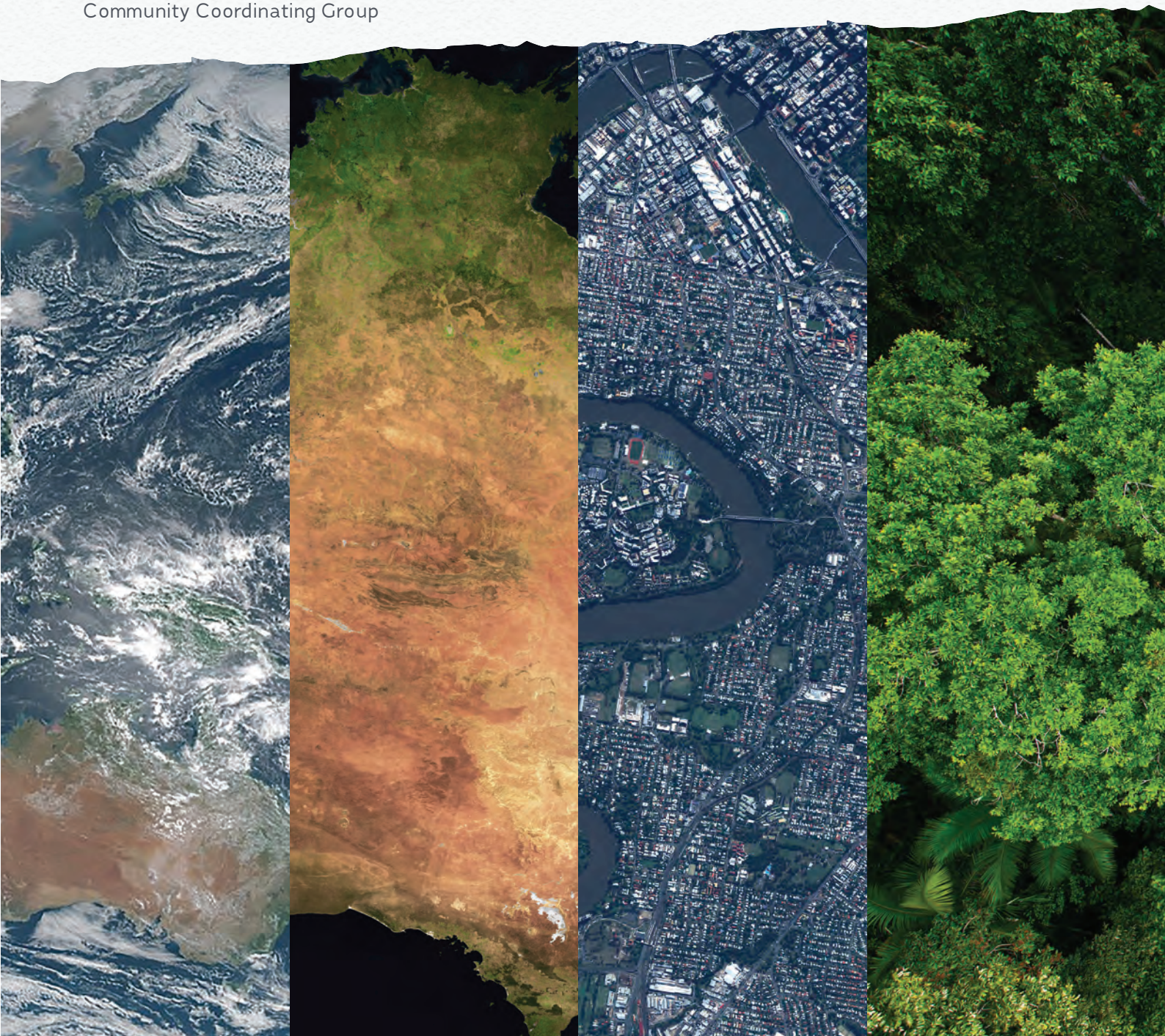
Australian Earth Observation Community Plan 2026

Delivering essential information and services for Australia's future.

AEOCCG

Australian Earth Observation
Community Coordinating Group



Acknowledgements

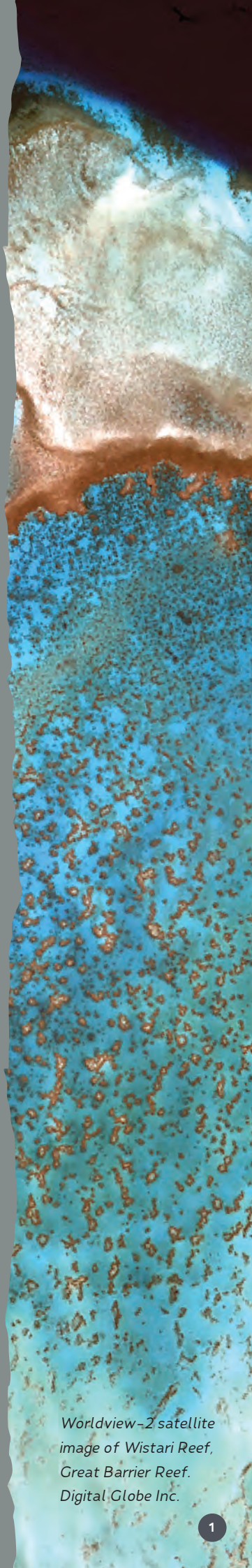
The majority of material in this Plan is derived from contributions across the Australian Earth Observation community, including people from government, industry, research and education. The process to develop the Plan was coordinated by the Australian Earth Observation Community Coordinating Group (AEOCCG) (see Appendix 2).

The process to develop this Plan was guided by a Steering Committee of people from across the EO sector, and the Committee was also actively involved in writing the Plan: Prof Stuart Phinn (AEOCCG Chair and Steering Committee Chair, University of Queensland (UQ)), Dr Arnold Dekker (CSIRO), Dr Alex Held (CSIRO), Agnes Lane (Bureau of Meteorology (BoM)), Dr Benoit Legresy (CSIRO), Dr Adam Lewis (Geoscience Australia (GA)), A/Prof Arko Lucieer (University of Tasmania), Dr Cindy Ong (CSIRO), Dr Dipak Paudyal (ESRI Australia), Chris Penning (CRC for Spatial Information (CRCSI)), Jonathan Ross (GA), Dr Chris Rudiger (University of Melbourne), Craig Smith (Surveying and Spatial Sciences Institute of Australia), Ben Starkey (Ozius Australia), Jamie Treleaven (BoM), and Stephen Ward (Symbios). Dr Tim Malthus (CSIRO) and Dr Bek Christensen (UQ) are also acknowledged for their assistance in writing the Plan.

Valuable feedback on the draft Plan was provided by the following reviewers: Prof David Antoine (Curtin University), Tim Danaher (Office of Environment and Heritage, NSW), Dr Gail Kelly (AAM Surveys), Prof Megan Lewis (University of Adelaide), Dr Stefan Maier (MAITEC), Sylvia Michael (Geoimage), Dan Tindall (Department of Science, Information Technology and Innovation (DSITI), Qld), Christian Witte (DSITI), and Dr Peter Woodgate (CRCSI).

Cover image: Himawari-8 image of Earth, courtesy of JMA and NOAA; a composite of Australia from NASA's Terra-MODIS sensor, sourced from NASA; World view-2 image of Brisbane, copyright DigitalGlobe Inc.

Contents



Worldview-2 satellite image of Wistari Reef, Great Barrier Reef. Digital Globe Inc.

A high resolution Worldview-2 satellite image of Brisbane (Digital Globe Inc.), and a surface cover-type map derived from this and airborne LIDAR data (Queensland Government). Data processed by D Wu and J Knight.

Executive Summary

Earth Observation — the suite of activities used to gather data about the earth from satellites, aircraft, remotely piloted systems, and other platforms — delivers spatial information that underpins our daily weather and oceanographic forecasts, disaster management systems, water and power supply, infrastructure monitoring, mining, agricultural production, environmental monitoring and more. Within Australia, Earth Observation is so commonly used across all levels of government, industry and society that the minimum economic impact of Earth Observation from space-borne sensors alone is approximately $5.3 billion each year.

We are currently seeing a step-change in Earth Observation globally that will radically change the volume and types of data available, the ability of populations to access and use its data and services, and the potential applications and value of Earth Observation products and services. As a nation we must be proactive in anticipating and responding to these changes to ensure Australia's capability in Earth Observation across government, industry, and research is able to adapt, grow, and deliver continued and increasing benefits for Australian society.

This Plan delivers a unifying focus to motivate and guide the Australian Earth Observation community to take a coordinated set of actions that will advance Australia's Earth Observation capability, while growing innovative partnerships across government, industry, and research and education to ensure Australia's economy, governments, society and environments are sustained and improved.

Australia has a solid foundation of data, knowledge, infrastructure and services on which to build its future Earth Observation capability, and this Plan establishes a clear vision to move the sector forward together: ***By 2026, the Australian Earth Observation sector will develop and deliver high-quality Earth Observation information, infrastructure, and services that are used widely by government, industry, research and the community in Australia and internationally.***

Five priority areas of action are needed to support this vision:

1. **Connection and Coordination** — establishing a consistent vision within the Australian Earth Observation community, and delivering processes for internal coordination to ensure effective collaboration, resource use, and advocacy for Earth Observation in Australia and internationally.
2. **Securing Australia's Role in the International Earth Observation Community** — Australia must be an essential component of the international Earth Observation capability, delivering benefits to the international community and securing our access to and involvement in international Earth Observation programmes.
3. **Infrastructure and People** — developing, supporting and sustaining a wealth of trained professionals and quality infrastructure to enable world-leading Earth Observation research, innovation and application development.
4. **Access to Earth Observation Data and Services** — ensuring all Australian Earth Observation producers and users can easily and reliably access the data and services they need.
5. **Generating Value** — strengthening end-user engagement to enable delivery of high quality Earth Observation products and services suited to user needs, and supporting commercial development of Earth Observation applications.

Effective linkage across all parts of the Earth Observation sector is critical to achieve this vision, and that is why this Plan was developed in consultation across the sector. With the support of emerging technologies, and full engagement across government, industry, and research sectors, the benefits of Earth Observation for daily life in Australia will continue to grow.

Purpose of the Plan

This Plan delivers a unifying focus to motivate and guide the Australian Earth Observation community to take a coordinated set of actions that will advance Australia's Earth Observation capability, while growing innovative partnerships across government, industry, and research and education to ensure Australia's economy, governments, society and environments can be sustained and improved.

The Plan has been prepared through open consultation with the Earth Observation community, including key stakeholders from universities, Earth Observation industry, and government bodies. Australia's Defence requirements for Earth Observation are not included in this Plan, although they are a major user of Earth Observation. Their requirements are assessed through the Department of Defence's 2016 Defence White Paper and the Attorney-General Department's Critical Infrastructure Resilience programme.

The Plan does not comprehensively review the state of Australia's existing Earth Observation capability or its challenges — these have been well-documented in many prior reports (see Appendix 1). Rather, this Plan builds upon the existing work, captures the sentiment of the Earth Observation sector, and is purposefully forward-looking. It is intended to be a catalyst to foster progress. The consultation with the Earth Observation sector in developing this Plan provides a powerful springboard to take the Plan forward in a way that expands the extensive engagement across government, industry, and research sectors.

Using LIDAR to take measurements of vegetation in Tasmania. M Schaefer.

Introduction

It is hard to imagine modern society in the absence of Earth Observation. Earth Observation technologies are used to collect data from satellite, aircraft, and remotely operated systems to deliver information and services that are now ubiquitous and so well integrated into daily activities in our society, economies and governments that they are largely 'unseen'.

Our daily weather and oceanographic forecasts, disaster management systems, water and power supply, infrastructure monitoring, mining, agricultural production chains, environmental monitoring and more, all use Earth Observation **(Figure 1)**.

Relevant, accurate, detailed and up-to-date spatial information is recognised as an essential resource for Australia's public and private sectors, and thus there is a strong need to continue to innovate and improve Earth Observation science and application in Australia and its territories. Earth Observation is vital to a range of sciences, as well as government and industry activities used to understand and manage our environments sustainably, from within urban residential blocks to the Australian continent, oceans and beyond. With the support of emerging technologies, and full engagement across government, industry, and research sectors, the benefits of Earth Observation for daily life in Australia will continue to grow.

'Earth Observation' (EO) encompasses a broad suite of activities that use remote sensing to gather observations and produce measurements and spatial data to monitor and examine our planet, its environments, human activities and infrastructure[1]. EO data are collected at a range of scales from centimetres to kilometres, throughout all our environments — built, natural, and managed. Some EO data have been collected regularly for decades through ongoing satellite programmes, while other data may be collected at specific times and places to respond to particular needs such as natural disasters or emergency situations.

Common Applications of EO

- Bushfire mapping
- Emergency and disaster response
- Energy resources
- Flood mapping
- Forestry
- Horticulture
- Infrastructure
- Land management
- Ocean monitoring
- Mining and mineral exploration
- Precision agriculture
- Research
- Urban and regional planning
- Water resource management
- Weather Forcasting
- Environmental monitoring

Figure 1

EO information and products *are routinely applied across a wide range of industries for economic and societal benefit, some of which are shown here. A comprehensive list of 200 EO applications can be found at www.skywatch.co/get-inspired*

1. In this document, we use the following meanings for commonly used terms: Data refer to raw images or observations with no or limited corrections; Data product refers to image data with a location and time attribute applied to them and other basic corrections applied; Spatial information refers to an image file with location and time attributes as well as advanced corrections applied to it, and transformed to a thematic (categorical, e.g. land-cover type) or quantitative (e.g. temperature, water depth) product so it can be used with other spatial data; Services are processes (e.g. code and algorithms) that use spatial information to generate maps, measurements, graphs or other outputs for a specific application e.g. fuel load mapping. These are now also referred to as 'spatial analytics'. Services can also include tools designed to help end-users explore spatial data products for their own purposes.

The EO supply chain starts with the collection of observations using a variety of platforms including satellites, aircraft, remotely operated vehicles (airborne or waterborne), and *in situ* sensors (Figure 2).

These platforms may be fitted with any number of sensors capable of collecting different kinds of image data from the full electromagnetic spectrum including visible, thermal, and micro-wavelengths as used by imaging radar. As a result EO sensors can 'see' and measure more than the human observer can, over larger areas, on a repeated basis. These observations are collected at different spatial resolutions (pixel size, and total area observed) and different revisit periods, from minutes to days to months. These raw data are then processed with ground- or water-based calibration and validation data to deliver data products, information and services about our land, oceans, atmosphere, and built environments that can be used for a wide range of applications including weather and oceanographic forecasting, preparedness and response to natural disasters like floods and bushfires, mineral exploration, precision agriculture, water resource management, urban planning, and environmental monitoring **(Figure 1).**

EO data are used for measuring and mapping:

(i) Categories of features, such as land use and cover, mineral deposits, infrastructure, roof types, weeds, etc.

(ii) Biological or physical properties, such as vegetation heights, fuel loads, crop yields, water depth, building heights, cloud height and thickness, temperature, and more.

(iii) Changes in (i) and (ii) over time, such as the detection of crop growth over time, or vegetation clearing, wind direction and strength, wave directions and strength.

The variety of spatial information products and services currently obtained from EO is very large, diverse and continually expanding, with multiple Australian and overseas reports consistently demonstrating: (1) the significant and growing economic value of spatial information produced from EO data for our economy and governments, and (2) the essential nature of these data for supporting critical government and industry activities that ensure our food, water and energy supplies, contribute to public health outcomes, and improve preparedness for and response to natural disasters (see Appendix 1). The potential growth in, and return from, EO-related applications derived from satellite and UAS information products and services are immense[2] .

Globally, the return on investment in EO is conservatively estimated to range between at least $2–$10 for every $1 spent, depending on the specific application[3]. With ongoing development of EO data acquisition and processing platforms there are countless opportunities for EO to increase its value to society in coming years. To enhance Australia's economic and social well being, Australia should invest strategically in our EO capability now in order to create a vibrant, innovative and highly productive EO sector that effectively links industry, government, research and the public for widespread benefit.

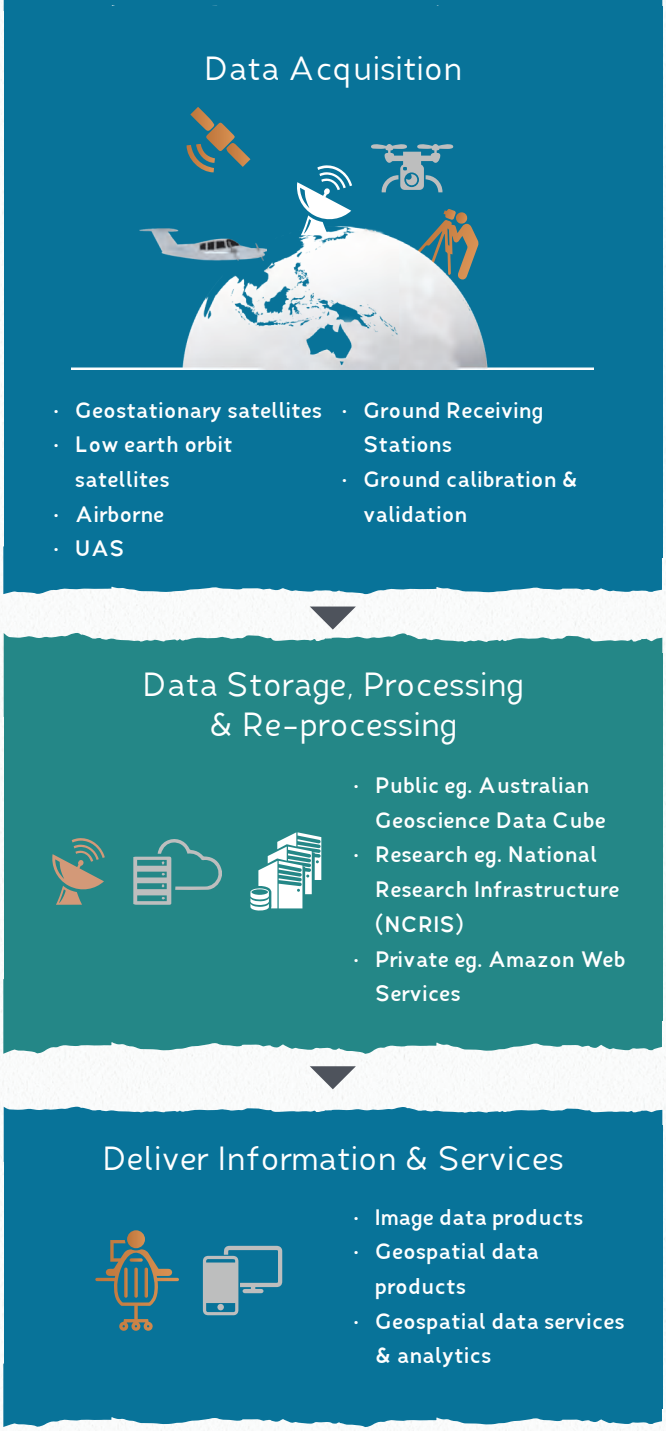


Figure 2

The EO 'supply chain' *from the acquisition of observations using a variety of sensors and platforms, through to the processing and storage of data and data products, through to provision of information and services that can be used in a wide range of applications.*

2. Coppa I, Woodgate PW, Mohamed-Ghouse ZS. (2016) 'Global Outlook 2016: Spatial Information Industry'. Published by the Australia and New Zealand Cooperative Research Centre for Spatial Information (CRCSI).

3. ACIL Allen Consulting (2015) 'The Value of Earth Observations from Space to Australia: Report to the CRC for Spatial Information; Henttu H, Izaret JM, Potere D (2012) 'Geospatial Services: A $1.6 Trillion Growth Engine for the U.S. Economy', The Boston Consulting Group.

Earth Observation in Australia

Australia has an active Earth Observation community distributed across research and education, government, private industry and NGOs **(Figure 3).** Although Australia does not operate any EO satellites, we are active across the entire EO supply chain beginning with the initial stages of data collection, storage, processing and distribution, and also in the research development of new EO sensors and processing algorithms. Our EO sector transforms EO data to value-added spatial information and services for government and industry and supports the end use of EO-based spatial information products and services by public and private sectors in everyday activities.

Australian government agencies at all levels have collected EO data over Australia since the 1940s, as evidenced by our extensive state-based aerial photo and image archives. Since the late 1970s we have moved to routine acquisition of satellite data, and since 2010 we have seen dramatic advances in:

1. The ability to collect EO data across multiple satellite, airborne, and other platforms such as unmanned aircraft systems (UAS) and the types of sensors these use; from digital photography to multi and hyper-spectral sensors, airborne LIDAR, and satellite radar and radiometry;
2. Improved access to these data from sites of a few square metres to continental and global scales on a regular basis; and
3. Our ability to store, process, analyse, visualise and distribute very large and long-term EO data sets online, and to deliver derived spatial information and services to a wide range of users through mobile devices and websites.

While Australia operates no EO satellites of its own, we access a wide range of satellite imagery, at moderate to low spatial resolution (20m — 1km pixels) through long-standing partnerships and arrangements with other countries. As part of these arrangements, Australia provides important ground station capability, highly skilled personnel, data access and distribution infrastructure, along with calibration and validation data to our international partners, and development of new algorithms and processing workflows. In combination, these activities add value to the available data for both our partners and ourselves. Access to higher spatial resolution data is through a range of private industry satellite, airborne, and UAS providers. The number and types of all these data sources are increasing continually.

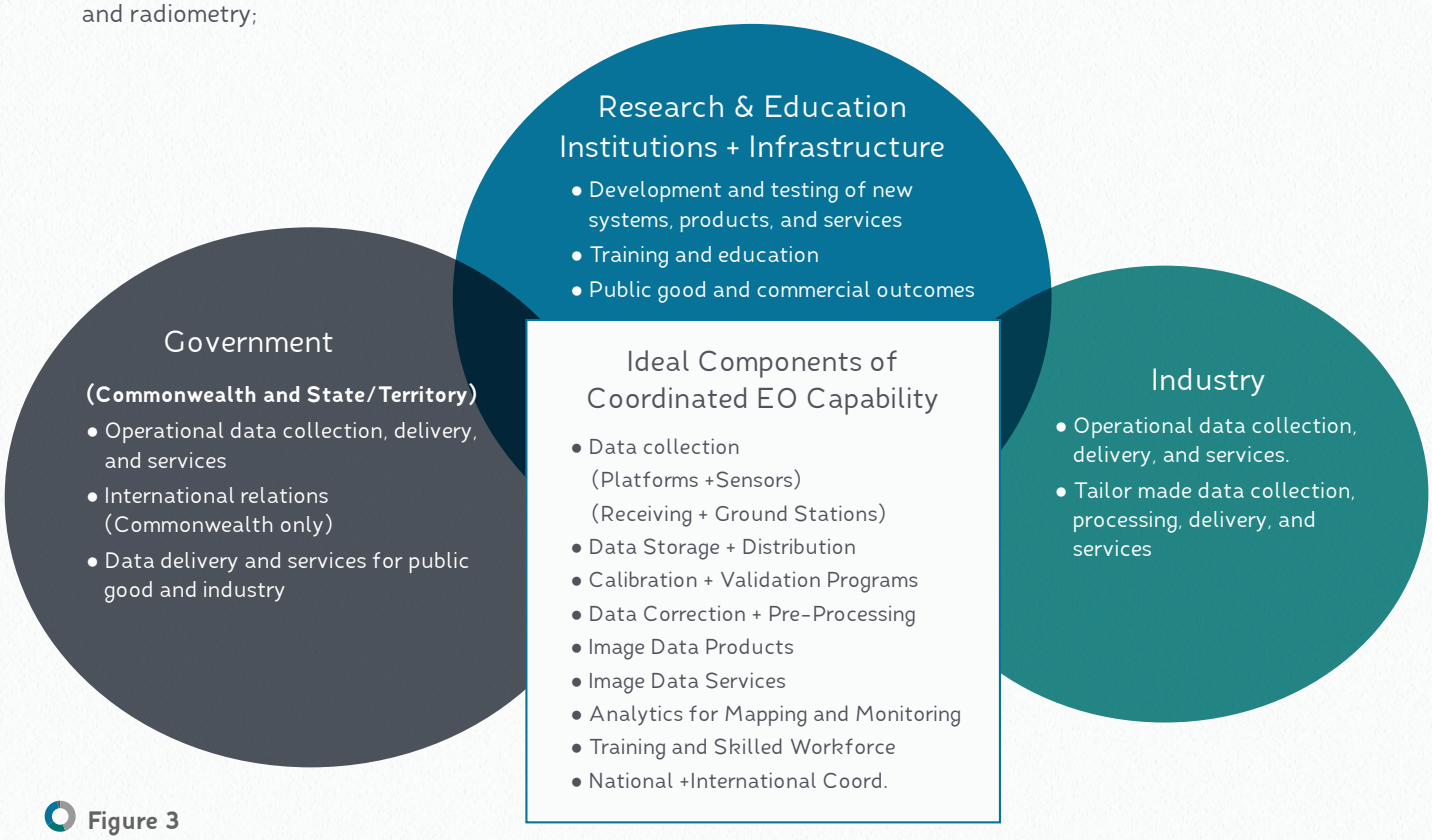


Figure 3

***The ideal coordinated EO capability for Australia**, with all components of this sector — government, industry, and research and education — delivering complementary activities to ensure an effective and cohesive national EO capability. The central box represents the combined requirements of a national EO capability, with the individual circles representing the different contributions from government, industry, and research and education sectors. Collaborative research infrastructure provided by the Commonwealth is an essential shared resource across all groups.*

Value of Earth Observation in Australia

EO services, delivered by both the public and private sector, are recognised as essential public-private infrastructure with numerous national reviews showing that Australian governments and industry are dependent on EO to maintain our economy and societal wellbeing[4]. Data and information applications from EO are now commonly used across all levels of government, industry and society in a range of sectors **(Figure 4)**. Over 140 Commonwealth, state and territory government programmes are dependent on EO from space, and the minimum economic impact of these observations on the Australian economy is approximately $5.3 billion per annum. These services are also estimated to have created more than 9000 jobs in 2015, and are projected to generate over 15000 jobs by 2025[5] . There are numerous examples of the economic and societal benefits generated from EO in Australia, across areas such as weather forecasting, onshore and offshore mining, mitigation and management of natural disasters like bushfires and floods, water resource management, design and assessment of conservation areas, insurance assessment, and land use planning (an excellent series of case studies showcasing the value of Earth Observation for different sectors is available in ACIL Allen (2015) 'The Value of Earth Observations from Space to Australia: Report to the CRC for Spatial Information').

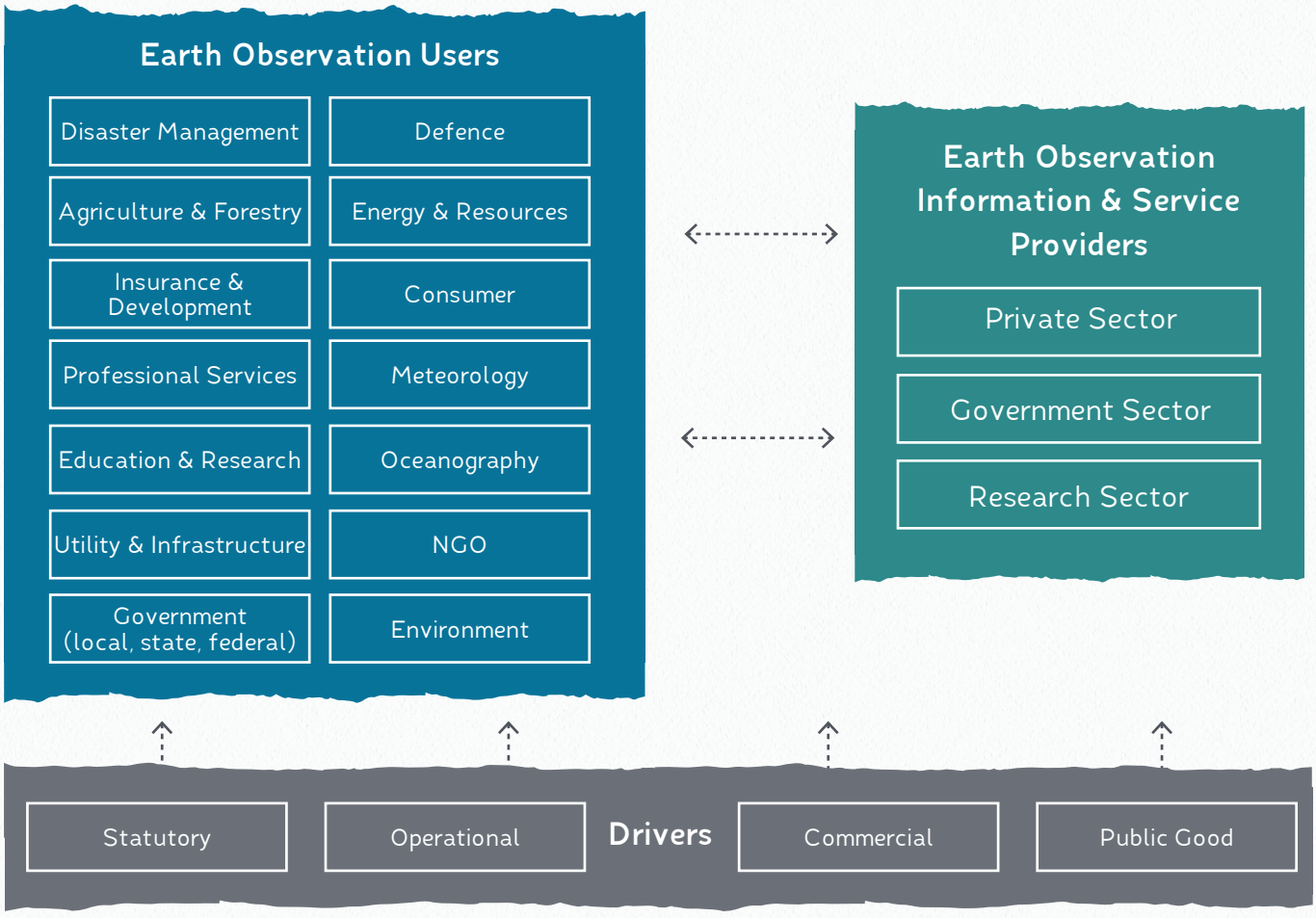


Figure 4

The users and providers of EO data products, information and services, and their drivers.

4. E.g. Senate Standing Committee on Economics (2008) 'Lost in Space? Setting a new direction for Australia's space science and industry sector', Canberra; Australian Academy of Science and Australian Academy of Technological Sciences and Engineering (2009) 'An Australian Strategic Plan for Earth Observations from Space', Canberra; Commonwealth of Australia (2013) 'Australia's Satellite Utilisation Policy', Canberra; Space Community of Interest (2015) 'A first pass analysis of risks associated with Australia's dependencies on space-based assets: Communications, Positioning, Navigation, Timing and Earth Observation.' Trusted Information Sharing Network for Critical Infrastructure Resilience, Attorney General's Department, Canberra, RESTRICTED ACCESS.

5. ACIL Allen Consulting (2015) 'The Value of Earth Observations from Space to Australia: Report to the CRC for Spatial Information'

Barriers for growth and innovation

While the existing impacts and level of dependence on EO in Australia are very significant in terms of diversity of activities and economic value, there is unrealised potential for the EO sector in Australia. Unless change occurs across the sector, this unrealised potential will grow, in effect translating to a net loss in essential capability for satellite, airborne and UAS data collection, processing and delivery. Some well-documented challenges will become significant barriers to growth if not addressed, including:

- Assuring coordination and a consistent vision within the EO community across research and education, government, and private industry, to ensure effective cooperation, collaboration, and use of resources within the sector, as well as improving advocacy by the sector at national and international levels. This vision needs to be backed by a clear strategy. When realised this will bring together a far more effective critical mass of expertise significantly increasing the value returned from Australia's investment in EO;
- Developing a clear, coordinated strategy to invest in and protect our international partnerships to ensure continued access to satellite data and international expertise, especially given our high dependency on foreign-owned satellite data;
- Providing clear pathways to develop, support and sustain the EO capacity required for Australia through skilled people, a growing knowledge base, and advanced data collection, storage, and analysis infrastructure;
- Effectively managing and enabling access to the very large and rapidly growing collections of EO data including historical archives and required new data streams, and taking advantage of new information systems technologies for storage, processing analysis, visualising and transfer, to overcome historical problems and future challenges with discoverability and access to the data, products and services; and
- Establishing connections between EO producers and users to enable the development of EO products and services suited to current and future user needs, and supporting the commercial development of EO applications to deliver productivity gains across the economy, amongst other societal benefits.

Why this plan, now?

We are currently seeing a step-change in EO globally that will radically change its sources, the ability of populations to access and use its data and services, and the potential applications and value of EO products and services for Australia in the coming decade. Australia's EO producer and user communities have indicated that substantial changes are required if we are to engage with these advances (Appendices 1 and 2).

A new generation of public-access and private EO satellite programmes, new opportunities from 'micro' satellites, rapid proliferation of UAS, and ubiquitous sensors in our environments will soon deliver an unparalleled deluge of complementary datasets at far more frequent coverage rates and finer spatial scales than previously achieved. Alongside this, new and more powerful storage and processing platforms through cloud computing capabilities and continued advances in computational hardware are enabling scalable processing of these data over small to large areas and timeframes, with output products and analytics for use in a range of contexts.

As a nation we must be proactive about taking advantage of these changes, ensuring a future Australian EO capability across government, industry, and research that can collect the right data, store and process it effectively, and deliver the right information in the right format at the right time to the right user.

Thankfully, Australia has a solid foundation upon which to build this future capability: we have invested wisely in building core EO data acquisition capabilities, and world-leading scientists and applications development in some government, industry, and research sectors. It is now time to build on this foundation, and establish a whole-of-EO-sector coordinated approach to grow our capability and provide the essential EO services of the future, so Australia's economy and society benefits. Effective linkage across all parts of the EO sector is critical, and that is why this Plan represents a holistic view on Earth Observation in Australia: it is inclusive of government at all levels, research, and the private sector, working in all parts of the EO life cycle from varying types of data acquisition (ground to air to space) to data processing and management, and application development.

Vision for Australian Earth Observation 2026

VISION STATEMENT: By 2026, the Australian Earth Observation sector will develop and deliver high-quality EO information, infrastructure, and services that are used widely by government, industry, research and the community in Australia and internationally.

The opportunities for future growth of EO in Australia for a wider range of beneficiaries are large:

By 2026 the familiar concept of the weather map, and its associated local forecast information and services, will be extended to all our environments. Australians will access services that measure and map the current states of our built, natural and managed environments, as well as services that help them plan for the future. Many of these services will be provided in real time, and in a way that is relevant to the location needs of the user, bringing them multiple benefits.

A suite of innovative private sector and government applications will evolve, underpinned by sustained investments in EO infrastructure, services, and expertise. Growth and collaboration in EO research across public and private sectors will enable new advances in infrastructure and capabilities that drives increased efficiency and knowledge at any scale and for multiple applications.

As a sector, EO will enable improved decision making across many areas of government and the economy. Companies and countries around the world will routinely benefit from our EO infrastructure and services. Advanced Australian EO infrastructure and capability will be an integral part of a global infrastructure and expertise, with Australia seen as a world-leading provider of EO infrastructure, information and services.

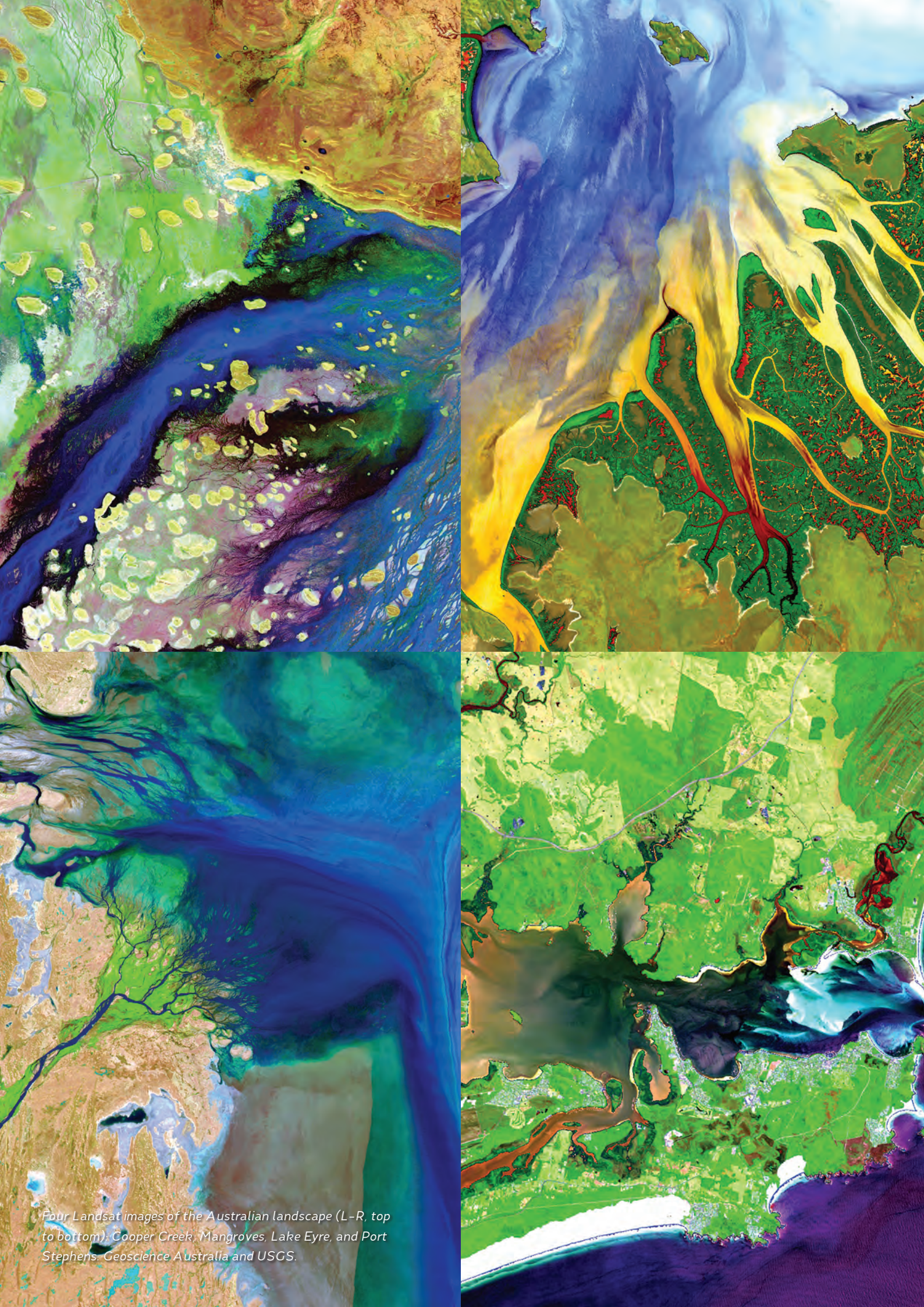
The vision will ensure that Australia takes maximum advantage of the power of the EO platforms and sensors that will become available over the coming decade.

To do any less will be like a handbrake on national growth and well being in this era of space.

This Plan outlines the priority areas for action needed to achieve this possible future, which are[6]:

1. **Connection and Coordination** — establishing a consistent vision within the Australian EO community, and delivering processes for internal coordination to ensure effective collaboration, resource use, and advocacy for EO in Australia and internationally.
2. **Securing Australia's Role in the International EO Community** — Australia must be an essential component of the international EO capability, delivering benefits to the international community and securing our access to and involvement in international EO programmes.
3. **Infrastructure and People** — developing, supporting and sustaining a wealth of trained professionals and quality infrastructure to enable world-leading EO research, innovation and application development.
4. **Access to EO Data and Services** — ensuring all Australian EO producers and users can easily and reliably access the data and services they need.
5. **Generating Value** — strengthening end-user engagement to enable delivery of high quality EO products and services suited to user needs, and supporting commercial development of EO applications.

6. The order of presentation of these priorities does not represent a hierarchy or degree of importance.



Four Landsat images of the Australian landscape (L–R, top to bottom): Cooper Creek, Mangroves, Lake Eyre, and Port Stephens. Geoscience Australia and USGS.

Priorities for future success

Priority 1: Connection and Coordination — establishing a consistent vision within the Australian EO community, and developing strong processes for internal coordination to ensure effective collaboration, resource use, and advocacy for EO in Australia and internationally.

A well-coordinated and closely connected Australian EO community results in improved strategic use of our national EO capability **(Figure 3)** with reduced duplication and competition between all parties, greater cross-sector collaboration and innovation, and ultimately better EO applications and outcomes for business and society. A well-coordinated and connected EO community is also better able to communicate the value of its work to the wider community, advocate for itself, and connect with the international EO community.

By improving coordination of the Australian EO community, we will ensure that both our EO-producers and end-users can jointly demonstrate the importance of EO across all sectors of business, government, and society. This will support the increased uptake and use of EO for wide-ranging societal benefit areas including local and urban planning, agribusiness, environmental monitoring, forecasting and preparedness for natural disasters and emergency responses, public health outcomes and more. Providing clearer lines of connection and communication will also enhance opportunities for users to define and communicate their needs to the EO sector.

The Australian EO community spans research, government, and industry players operating in all parts of the EO life cycle from data acquisition through to application development. Within this mix are government agencies with mandated roles to deliver EO services (both federal and state/territory), researchers working across a wide range of disciplines from oceanography to mineral exploration, and commercial operators delivering EO data and services to an increasingly diverse set of users. While there is some connection across these groups, until the recent formation of the Australian Earth Observation Community Coordination Group there has been no established forum for widespread information sharing, collaboration and coordination. Previous professional associations have focused on specialised sectors of EO, and while this kind of specialised focus is entirely appropriate for the needs of particular groups, the lack of a whole-of-community coordinating mechanism has undermined the EO community's capacity to work effectively together, take advantage of new opportunities, and demonstrate its impact on society. It has also resulted in a lack of clarity about the roles and contribution of different groups, leading to duplication of effort and hence inefficient use of resources across sectors at times.

Actions needed:

1.1 Formation of a national Earth Observation coordination mechanism with a clear mandate and operational funding to provide a central point of connection and coordination for all sectors of the EO community in Australia. This will enable the identification and communication of essential EO needs, better strategic investment in the sector to achieve goals, and a clear mechanism for advocacy on behalf of the EO community.

1.2 Development of new national EO forums (e.g. targeted seminars, webinars, online resources, workshops, conferences) to enable collaboration across the EO community and between the EO community and end-users in activities such as agribusiness, planning, environmental monitoring, resources and utilities. This includes building links to the spatial sector and the space sectors through their coordinating bodies, actively engaging with national science and innovation bodies and research infrastructure programmes.

Priority 2: Securing Australia's Role in the International EO Community — Australia must be an essential component of the international EO capability, delivering benefits to the international community and securing our access to and involvement in international EO programmes.

Australia is currently one of the largest users of satellite EO data worldwide, with these data coming from foreign governments and the private sector. Our access to these data is negotiated through partnership agreements, with Australia working to support the objectives of our partners and help them achieve efficiencies in their programmes. These partnerships are assessed as being at moderate to high risk under current arrangements, and require urgent attention to reduce the risk[7].

Regardless of any sovereign capabilities that may be developed, access to observations from the global constellation of satellites delivers greater outcomes for the Australian community than an approach focused solely on sovereign capability. In addition, having Australians engaged across the lifecycle of satellite programme development improves the usefulness of those programmes for Australian needs.

To establish our place and role in the international EO community, by 2026 we must ensure there is strong and coordinated government, industry, and community support for investment across the entire EO value chain, including international cooperation activities, and ensure that Australia is seen as a valued contributing member of the international EO community across all sectors: government, industry, and research and education.

At a national level, Australia currently has partnerships in place with a range of nations that supply critical EO data. A range of individual industry players, researchers, and other experts are also participating in international projects. Australia delivers critical ground station capability for a number of international government and private industry partners. Our calibration and validation of satellite EO data also provides invaluable quality assurance for partners, because of our geographic location, diverse landscapes, and expertise. This current engagement in efforts to calibrate and generate value from EO data internationally:

- Builds international 'good will' for Australia
- Enables Australia to accelerate domestic uptake of EO data, by learning from the international community,
- Showcases our capabilities in development of new platforms for managing and processing petabytes of EO data for multiple applications, and
- Leverages our capability to help other countries benefit from geospatial information.

The strategic and long-term coordination of our international partnership activities must be improved, including financially appropriate long-term investment that provides certainty for our partners, and for our EO community who want to take advantage of the opportunities presented in these partnerships. To date, the capability of Australian industry has also been underutilised and there is significant unrealised potential to engage in the emerging satellite, airborne, and UAS applications market, for delivering image-based information products and spatial analytic services, which by their very nature have global export potential.

7. Space Community of Interest (2015) 'A first pass analysis of risks associated with Australia's dependencies on space-based assets: Communications, Positioning, Navigation, Timing and Earth Observation.' Trusted Information Sharing Network for Critical Infrastructure Resilience, Attorney General's Department, Canberra, RESTRICTED ACCESS

Actions needed:

2.1 Establish and resource a transparent and inclusive mechanism to coordinate Australia's strategy and partnerships with priority space agency partners, public and private, working in the interests of and in consultation with the Australian EO community.

2.2 Develop a robust process to assess options and costs/benefits for meeting Australia's EO satellite data needs for the future and compare possible options including, but not limited to: (1) major and ongoing financial contribution to international public and/or private space programmes to ensure Australian input to design of missions and ongoing access to data and services, (2) development and deployment of dedicated Australian EO satellite(s).

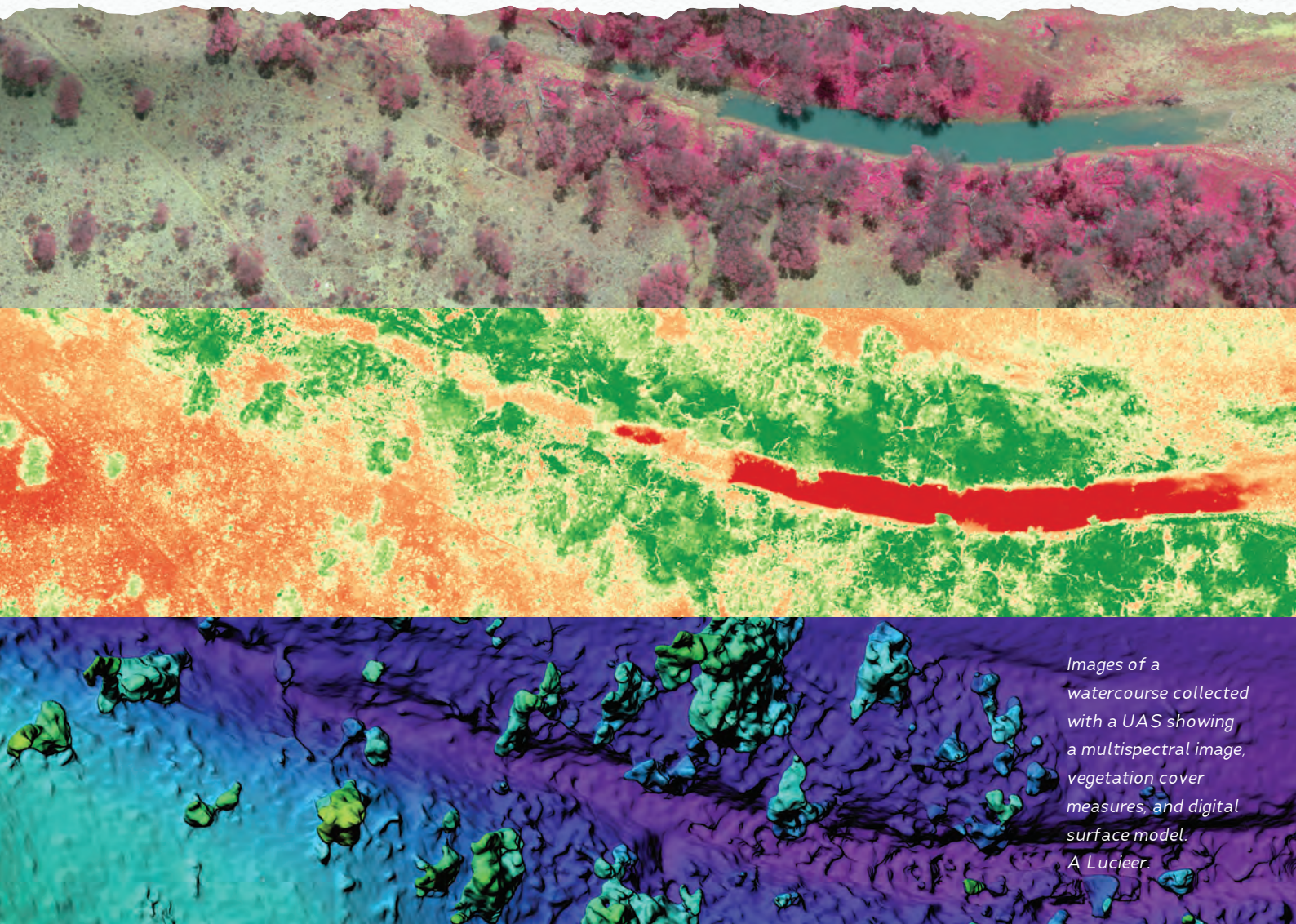
2.3 Consistent with their mandates, relevant government agencies continue to provide strategic and sustained support for ground station facilities that support international partners.

2.4 Establish a formal programme and partnerships that bring the Australian EO community together to co-invest in a suite of internationally relevant calibration and validation sites and facilities, to run on an operational basis with long-term certainty.

2.5 Support, engage with, use and expand on government-funded essential infrastructure that enhances access and use of satellite data, including data access and analysis hubs such as the Copernicus Hub.

2.6 Government agencies and research institutions financially support and encourage participation of Australians in teams for key international programmes, such as science teams and validation teams.

2.7 Consistent with their mandates, relevant government agencies promote Australia's capability and willingness to contribute to the international EO community, e.g. using the embassy network, trade delegations, and relevant multi-lateral forums.



Images of a watercourse collected with a UAS showing a multispectral image, vegetation cover measures, and digital surface model. A Lucieer.

Priority 3: Infrastructure and People — developing, supporting and sustaining a wealth of trained professionals and quality infrastructure to enable world-leading EO research, innovation and application development.

We are already witnessing a significant change in EO globally, with a rapid proliferation of EO data acquisition platforms (from satellites to UAS) at finer temporal and spatial scales, and improving computing capability and approaches for processing and analysis. Based on the opportunities presented by these changes, use of EO is projected to grow significantly with uptake across a wider range of industry applications[8]. Yet new publicly funded satellite programmes, along with rapidly emerging commercial capabilities, are already challenging Australia's infrastructure and data management capabilities. To fully realise the benefits of EO data for the future, Australia requires skilled people and adequate infrastructure to facilitate the acquisition, download, transfer, processing, analysis, and use of EO data and services.

With the right planning and investment, in ten years' time we can have a sustainable and scalable national EO data infrastructure that ensures high speed, low latency access and transfer of critical data and derived information streams from multiple sources. It can create clear pathways for the uptake and use of data by industry as well as government and research institutions. In addition, systems for effective and efficient data stewardship and analysis need to be established to realise the benefits of these data.

This infrastructure will be supported by a workforce that has: (a) understanding of EO data and the range of spatial information products and services; (b) the ability to collect, store, process, analyse, and visualise EO data, and produce services for government, industry and research; and (c) capability to integrate EO data with other forms of spatial and demographic information to deliver innovative applications to address environmental, social, and economic challenges. This workforce and infrastructure will engage with an 'EO-savvy' user community who are equipped to understand how EO can be applied to their needs, and to discern the appropriate EO services for their needs.

To achieve this we will have to build pathways that train people — including EO users — with a combination of skills in the fundamentals and applications of remote sensing, alongside data handling and analysis, to produce data scientists and remote sensing specialists, as well as those who can extend these capabilities to a wider audience. We also need access to assured, affordable, high-speed communications, and long-term security of spectrum licensing from other communication needs (such as mobile phone transmission) to maintain the ability to collect and transmit essential satellite and airborne data streams to ground receiving stations. As noted elsewhere in this Plan, building on our existing calibration and validation facilities will also increase the quality assurance and hence trust in EO outputs.

Actions needed:

3.1 Promote increased investment in education and training to ensure that the next generation of EO-application developers and users are being provided with the appropriate EO background and software skills.

3.2 Promote increased investment by Australian governments into the core infrastructure and trained professionals required to receive, store, process and make EO data publicly accessible in formats relevant for subsequent users.

3.3 Effectively coordinate and promote investment in infrastructure to meet research and industry needs including data portals, processing of raw data into data products tuned to Australian conditions, calibration and validation of these datasets, and user-friendly web-based access to data products.

3.4 Develop a coordinated national plan for spectrum assurance and scheduling.

3.5 Australian EO community to develop and annually update a statement of infrastructure requirements, covering critically significant ground station facilities, communications links, storage and archival facilities, processing facilities, calibration and validation sites, and any other infrastructure needs (linked with the assessment of data needs identified under Priority 4). An initial statement of needs for government and research is already available as supporting documentation for this Plan[9].

8. ACIL Allen Consulting (2015) 'The Value of Earth Observations from Space to Australia: Report to the CRC for Spatial Information'

9. See http://www.aeoccg.org.au/aeocp-the-plan/

Priority 4: Access to EO Data and Services — ensuring all Australian EO producers and users can easily and reliably access the data and services they need.

The EO supply chain depends upon reliable access to the right EO observations through data infrastructure with low technical and cost barriers. By 2026 we must ensure that current and near future (within 5 years) requirements for EO data across government, industry, and research and education are understood and re-assessed on a regular (annual) basis, and that these data are systematically collected and made accessible at scales from local to continental to global.

Where in the public interest we need to ensure that Australian governments make EO data, infrastructure, products and services available that are consistent with the requirements and priorities identified by the EO community. Where provided by the private sector, EO data need to be supplied in a consistent and standardised form to meet the needs and priorities identified by the EO community and users.

In future, all datasets, historical and new, will be available in usable forms through a set of platforms and services that minimise waste and duplication, enable effective use, and foster linkages between different EO users and producers. In addition, national efforts to develop new techniques that make EO data accessible and usable will be well coordinated, and have pathways to apply these techniques on an operational basis.

There are two key components to meet these future targets:

1. Ensuring that the correct observations are made and acquired to support the needs of all EO producers (research, government, industry) and EO users, and that this process is as transparent, predictable and stable by; and
2. Making those observations discoverable and usable through data infrastructure that is reliable, and that has cost models suitable to meet the needs of different sectors at different stages of business and product evolution. There is a key role for government in delivering core public good infrastructure, supporting and complementing platforms that may be delivered by research and industry to suit specific user needs. This also includes providing programmes that enable private industry to build essential EO data products and services off government infrastructure that is stable and guaranteed to be in position.

Data requirements for government and research purposes have been well documented in the past; however, there is a lack of clarity about the data that could best stimulate our value-adding industry. Existing assessments of data requirements focus on satellite EO, and not on other essential data acquisition platforms such as aircraft and UAS. Current understanding of data requirements is also typically restricted in focus to Australia and its territories, and doesn't address the broader region in which Australia has a critical interest.

While some key datasets are readily discoverable, many datasets are hard to find and access. In addition to this, a range of important datasets remain in archives and 'unlocking' them can only be achieved through significant and sustained investment in infrastructure, processes, relationships with foreign agencies, trained personnel, and scientific and legally accepted validation to deliver them in a form fit for use.

EO datasets are often large, and 'raw' data typically require preparation to make them suitable for users' specific requirements, which can vary significantly. Where the techniques to generate user-friendly products are developed, there may not be arrangements to ensure

these are provided on a reliable operational basis. Real-world problems require integration of data from different platforms and sensors, and these remotely sensed data invariably provide additional value when used in combination with data from a range of other sources.

We have the right building blocks to tackle these challenges. These include close links between state and federal agencies, resulting in sustained access to critical satellite EO data; government investments in supercomputing and science that can be leveraged; computing facilities that have the capability and capacity to make large volumes of complex datasets available in a way that supports high-performance analysis from local to continental to global scales of research; and public-private partnerships that enable data sets and other outputs to be accessed and used in an operational context (24/7).

Actions needed:

4.1 Undertake ongoing and periodic assessment of EO data requirements that includes regional and industry requirements, and non-satellite data sources.

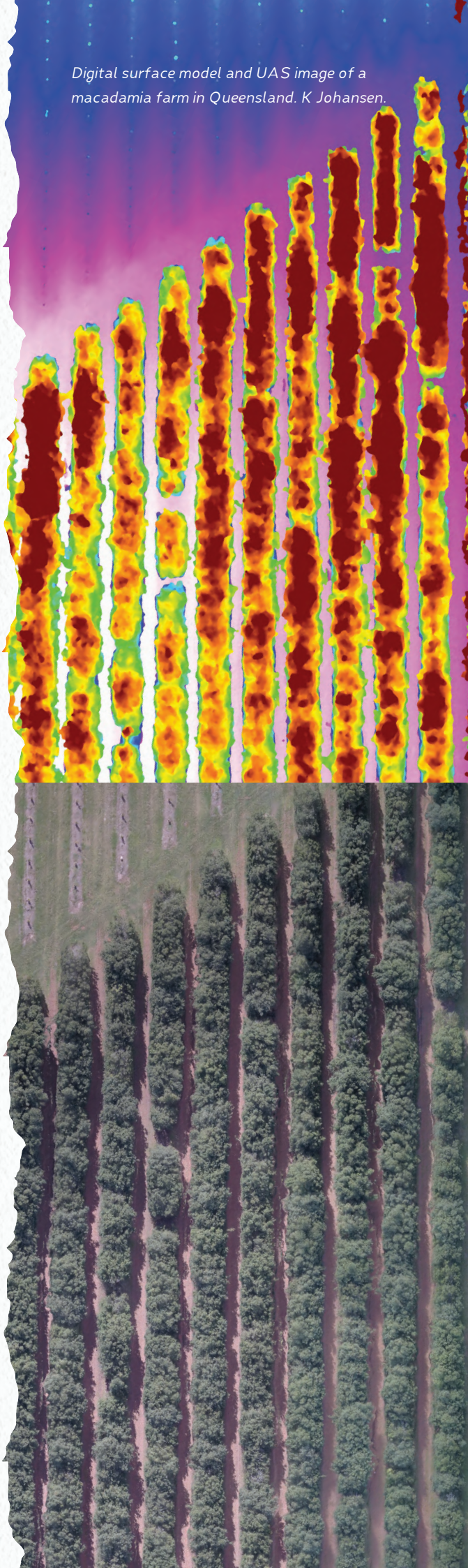
4.2 Increase investment in long-term partnerships with international space agencies able to provide critical public good datasets, building on existing responsibilities of operational government EO agencies in partnerships across national-state levels, and with research and industry (see also Priority area 2).

4.3 Ensure efficient and predictable access to key public good EO datasets delivered through operational government EO agencies.

4.4 Establish a centralised website, maintained by the EO community, with an up-to-date overview of scientific and commercial EO data acquisition, locations of data, access protocols, description of processing levels, description of routine data products and analytic services.

4.5 Encourage relevant agencies to work closely with major computing facilities to facilitate access to public data, and data analysis tools, for the whole Australian EO community.

4.6 Establish mechanisms to facilitate the spread of state-of-the-art knowledge and techniques, define EO standards, and EO best practices.



Digital surface model and UAS image of a macadamia farm in Queensland. K Johansen.

Priority 5: Generating Value — strengthening end-user engagement to enable delivery of high quality EO products and services suited to user needs, and supporting commercial development of EO applications.

By 2026 Australian EO information and services will be used broadly as a matter of course by a wide range of industries and the general public, and as a trusted decision-making tool. Strong connectivity and communication across the EO community and with other industry sectors will result in increasing numbers of joint research projects, value added products, and paths to impact for research outcomes. We will become a leading provider of EO services worldwide, strengthening our place in the global EO landscape.

There are already good examples of cross-sector collaboration and commercial EO benefits through our Cooperative Research Centres (past and present), Joint Remote Sensing Research Program and the Australian Earth Observation Community Coordination Group. However, further improvements in collaboration with end-users of EO data will assist in realising the commercial benefit from EO products and services in Australia and globally.

The current disconnect between EO producers and potential users means the benefits of EO are not being fully exploited by all beneficiaries. Concerted efforts to communicate and extend these benefits and the real world applications of EO are critical to driving user uptake and long-term demand. The EO community has a responsibility to actively work with potential users in all markets to better understand their respective needs and to assist them in the application of EO solutions.

Adapting quickly to changing conditions in the market will suit small and medium-sized enterprises (SMEs) in the EO sector that provide value-added products and services, and that can move quickly to meet the market's needs. To support growth, policies and processes must be designed in ways that can maximise the commercial potential of private EO service providers. Australia has the potential to lead a rapidly emerging global EO service market, but could well miss out as other countries scale up their support for SMEs in this sector.

As the uptake of EO applications grows in coming years, the Australian EO community must also maintain strong quality assurance standards underpinned by calibration and validation processes, to ensure they are delivering high quality and trusted products. As the commercial benefits of EO are realised by a growing user base, it is vital that we maintain the high quality of our EO products, which in turn assures trust in those products and an ongoing demand for the products and services our sector can offer.

Actions needed:

5.1 Create a communication and marketing plan that expresses the benefits of EO for different end-users, and that highlights the potential of EO services as a growing industry.

5.2 Lobby for the development of favourable policies to advance the commercial potential of EO services, increasing the uptake of EO products and services and subsequently driving further investment in the sector.

5.3 Measure and record the uptake and economic benefits of EO across different sectors.

5.4 Clearly articulate the benefits of our calibration and validation facilities, and maintain and grow investment in these to ensure our EO products are accurate, leading edge and world class.

5.5 Develop a Standards-Based Approach for the capture, analysis, storage and dissemination of EO data, information and services to ensure ongoing confidence in our EO products and services.

5.6 Advocate for innovation programmes, grants and subsidies to encourage entrepreneurship in the EO service industry.

Next steps

This Plan has been developed by the Australian EO Community, through a process facilitated by the Australian EO Community Coordinating Group (AEOCCG). While the AEOCCG will take a lead role in championing this Plan and monitoring progress towards implementation of its recommended actions, the full potential of EO and our vision for 2026 will only be achieved through coordinated effort and action by the EO community as a whole. This means that the AEOCCG needs to renew efforts to reach out and engage widely across the EO community, to ensure there is ownership of and participation in actions for the future.

Implementation of the actions suggested in this Plan will need real financial and individual support across government, industry, and research and education.

An indicator of the significant support needed can be seen in other similar countries (e.g. Canada and the United Kingdom) where a central EO agency is funded specifically to coordinate strategic planning and activities across the entire EO sector. Clearly, the proposals outlined in this Plan will not be achieved by one organisation or well-meaning individuals in the EO sector, but by coordinated and resourced action across the community as a whole. With appropriate support, there is no doubt that Australia can deliver a significantly expanded national EO capability — encompassing public and private sectors — that is highly innovative and can enable us to maintain our high quality of life, healthy environments and strong economy.

To initiate action in implementing this Plan, the AEOCCG commits to:

1. **Engaging widely across the EO community** to seek feedback on the actions set out in this Plan, and to determine what the community sees as the important areas for action in the short- (< 5 years) and long-term (5-10 years), in order to develop an implementation plan and the required financial, personnel and other resources to address this.
2. **Linking the AEOCCG to a suitable agency** or programme able to work across a range of Government agencies to implement the actions required under the five priorities of the Plan, and to develop a linked EO Capability for Australia across government, industry, and research.
3. **Establishing working groups** or other groups with membership from across the EO community, who will take responsibility for progressing specific actions or priority areas of this Plan and work in close association with the coordinating programme established in 2.
4. **Build the case** for and obtain government and external investment for developing and implementing the Plan, and seek sources of funding to support implementation activities in the short- and long-term.
5. **Promoting the Plan**, its priority areas, and key actions to decision-makers and influencers in government and other sectors in order to build wider support for implementing the Plan.

Princess Charlotte Bay from Landsat-8 OLI. Geoscience Australia and USGS.

Appendices

A1: List of assessments, studies and plans about EO in Australia since 2008

2008	ACIL (2008). The Value of Spatial Information: The impact of modern spatial information technologies on the Australian economy. CRC Spatial Information, ANZLIC- The Spatial Information Council. Melbourne, Australia.
2008	Australian-Government, Senate Standing Committee on Economics (2008). Lost in Space? Setting a new direction for Australia's space science and industry sector. Senate Standing Committee on Economics Report. Canberra.
2009	Australian Academy of Science (AAS) and Australian Academy of Technological Sciences and Engineering (AATSE) (2009). An Australian Strategic Plan for Earth Observation from Space. Canberra.
2009	AAS and AATSE (2009). Decadal Plan for Australian Space Science 2010-2019. Canberra.
2010	ACIL-Tasman (2010). Economic Value of Earth Observation from Space. Canberra.
2010	Australian-Government (2010). Adapting to Climate Change in Australia—An Australian Government Position Paper. Canberra.
2010	Geoscience Australia (2010) A National Space Policy: Views from the Earth Observation Community. Canberra.
2011	Geoscience Australia (2011). Continuity of Earth Observation Data for Australia: Operational Requirements to 2015 for Lands, Coasts and Oceans (CEODA-Ops). Canberra.
2012	Australian-Government-Environmental-Information-Advisory-Group (2012). Statement of Australian Government Requirements for Environmental Information. Canberra.
2012	Cooperative Research Centre for Spatial Information (CRCSI) and CTG Consulting (2012). Robust Imaging from Space - Satellite SAR (Synthetic Aperture Radar). Canberra.
2012	CSIRO (2012). Continuity of Earth Observation Data for Australia: Research and Development Dependencies to 2020 (2012, CEODA-R&D). Canberra.
2013	CRCSI (2013). Australia and SAR: A Road Map. Canberra.
2014	Australian-Government (2014). The State of Space Report: Australian Government Space Coordination Committee 2014.
2014	CRCSI (2014). Australian Strategic Plan for GNSS. Canberra.
2015	ACIL Allen Consulting (2015). The Value of Earth Observations from Space to Australia.
2015	Symbios Communications (2015). Risks of Data Supply of Earth Observations from Space for Australia.

A2: EO community survey: a summary

The AEOCCG has held regular, open, whole-of-EO-community online meetings as webinars since April 2013 to enable discussion of key issues affecting the community (www.aeoccg.org.au/community-meetings). The need for developing and implementing this Plan was identified as a common requirement in many of these meetings, to enable the EO community to progress, and for government and industry to be informed of the community's needs.
To obtain a suitable base of information for the Plan an online survey was conducted in July - September 2016 to gather information about challenges currently experienced by those working in EO in Australia, and also to gather ideas about key activities required for the future of EO in Australia **(www.aeoccg.org.au/aeocp-national-survey).**

The questions asked, in addition to some background context of each respondent, were:

1. Why is Earth Observation important for Australia?
2. What are the current and future challenges you face in producing and/or using EO data?
3. What do you consider are the priority areas for action to ensure Australia's EO data producers and users can be sustained and grown effectively over time?
4. What are your top three ideas for growing and strengthening EO data collection, storage, processing, analysis and distribution in Australia over the next 20 years or longer?

Survey responses

The Steering Committee for the Plan reviewed all survey responses, and identified common themes across the submissions. The responses received highlighted a shared understanding across the community of the value of EO for Australia, and also a shared concern that the full potential of EO in Australia is not realised currently. There was clear agreement that strategic actions should be taken to enhance and grow Australia's EO sector and its activities.

The common themes identified in the responses to Question 2 (challenges) were mirrored through the responses to Questions 3 and 4 (ideas for the future and areas for action). These themes were synthesised into the five priority areas that are expressed in the final Plan:

1. Connection and coordination
2. Securing Australia's role in the international EO community
3. Infrastructure and people
4. Access to EO data and services
5. Generating value

Survey respondents

59 people responded to the survey. The survey was anonymous, but respondents provided information that enabled some understanding of their professional context and links to EO in Australia. For example:

- When asked to rate their usage of EO from '0 — not at all' to '5 — whenever we can', 87.9% of respondents selected a rating of 4 or 5.
- 84.5% of respondents indicated that they think there is potential to use EO more in their area of business.
- 25.9% of respondents would only use 'free' EO data (data available at no cost to the user), 29.3% spend up to AU$49, 999 on EO each year, and 19% spend more than AU$200, 000 on EO.

Respondents came from a range of locations across Australia:

State/Territory	%	Count
ACT	13.6	8
NSW	18.6	11
NT	0	0
QLD	25.4	15
SA	5.1	3
TAS	11.9	7
VIC	15.3	9
WA	8.5	5
OTHER	1.7	1

Respondents came from a mix of organisations:

Primary affiliation	%	Count
Commercial company	6.8	4
CSIRO	11.9	7
Federal Government Agency	18.6	11
Local Government Agency	1.7	1
None — self-employed	5.1	3
None — not currently working	1.7	1
Non-government group or association	0	0
State/Territory Government Agency	16.9	10
University	35.6	21
Other research organisation	0	0
Other	1.7	1

AEOCCG

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