

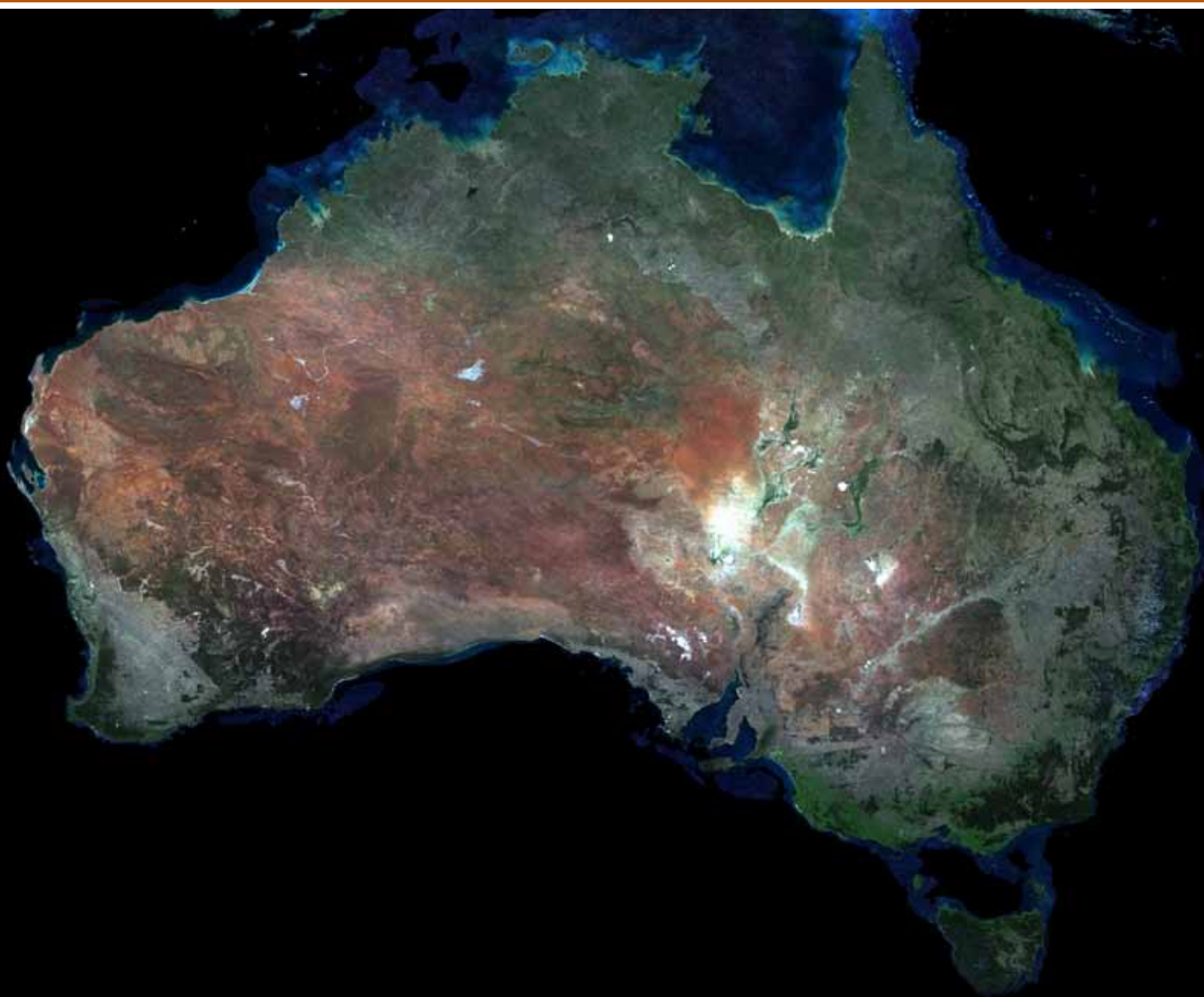


Australian Government

Geoscience Australia

A National Space Policy:

Views from the Earth Observation Community



National Earth Observation Group

Department of Resources, Energy and Tourism
Minister for Resources and Energy: The Hon. Martin Ferguson, AM MP
Secretary: Mr Drew Clarke

Geoscience Australia
Chief Executive Officer: Dr Chris Pigram



© Commonwealth of Australia, 2010

With the exception of the Commonwealth Coat of Arms and where otherwise noted, this product is provided under a Creative Commons Attribution 3.0 Australia Licence.

<http://creativecommons.org/licenses/by/3.0/au/deed.en>

Geoscience Australia has tried to make the information in this product as accurate as possible. However, it does not guarantee that the information is totally accurate or complete. Therefore, you should not solely rely on this information when making a commercial decision.

GeoCat # 70590

Cover image: Surface reflectance image of Australia in May 2010 using a 16 day composite from MODIS (Geoscience Australia)

Table of Contents

- 1. Executive summary2
- 2. Background3
- 3. State of Australian Earth Observations from Space6
 - 3.1. Federal and State programs dependent on EOS.6
 - 3.2. Economic assessment of EOS8
- 4. Seventh National Remote Sensing Technical Reference Group (NRSTRG) and distributors meeting 9
 - 4.1. Recommendations of the Seventh NRSTRG and distributors meeting10
 - 4.2. Risks12
 - 4.2.1 High risk classification12
 - 4.2.2 Medium risk classification.13
 - 4.2.3 Low risk classification14
 - 4.3. Mitigations15
- 5. Appendix A. Drafting Group16
- 6. Appendix B: Seventh NRSTRG and distributors meeting, Canberra, Friday 19 February 2010, delegates:17
- 7. Appendix C: References and reading18
- 8. Appendix D: Australian Federal and State programs dependent on Earth Observation.19

1. Executive summary

Australia has been receiving Earth Observations from Space (EOS) for over 50 years. Meteorological imagery dates from 1960 and Earth observation imagery from 1979. Australia has developed world-class scientific, environmental and emergency management EOS applications. However, in the top fifty economies of the world, Australia is one of only three nations which does not have a space program. The satellites on which Australia depends are supplied by other countries which is a potential problem due to Australia having limited control over data continuity and data access.

The National Remote Sensing Technical Reference Group (NRSTRG) was established by Geoscience Australia as an advisory panel in 2004. It represents a cross-section of the remote sensing community and is made up of representatives from government, universities and private companies. Through the NRSTRG these parties provide Geoscience Australia with advice on technical and policy matters related to remote sensing. In February 2009 the NRSTRG met for a day specifically to discuss Australia's reliance on EOS, with a view to informing the development of space policy. This report is the outcome of that meeting.

Australia has some 92 programs dependent on EOS data. These programs are concerned with environmental issues, natural resource management, water, agriculture, meteorology, forestry, emergency management, border security, mapping and planning. Approximately half these programs have a high dependency on EOS data. While these programs are quite diverse there is considerable overlap in the technology and data.

Of Australia's EOS dependent programs 71 (77%) are valued between \$100,000 and \$10 million and 82 (89%) of all these programs have a medium or high dependency on EOS data demonstrating Australia's dependency on space based imaging.

Earth observation dependencies within currently active Federal and state government programs are calculated to be worth just over \$949 million, calculated by weighting the level of dependency on EOS for each program. This includes two programs greater than \$100 million in scale and one program greater than a billion dollars in scale.

This document is intended as a summary of Australia's current space and Earth observation dependencies, compiled by the NRSTRG, to be presented to the Federal Government's Space Policy Unit, a section of the Department of Innovation, Industry, Science and Research, as an aid to space policy formation.



Landsat 5 image of Canberra and Lake George from 7 April 2009

2. Background

Australia is a major user of, and beneficiary from, space-based Earth observation. However, Australia is one of only three exceptions in a list of the top fifty national economies, ranked by the World Bank, which do not have their own space program. Despite this, some seventy Federal and State organisations and agencies receive and make regular use of Earth observation and remote sensing instruments, on satellites launched by the United States, Japan, India, China, Korea, UK, France, Germany, Italy, Nigeria and the European Commission. Geoscience Australia, CSIRO and the Bureau of Meteorology operate numerous satellite receiving stations and process this data for internal uses or for delivery to external public and private users.

The Australian Academies of Science and Technological Sciences and Engineering jointly released an Australian Strategic Plan for Earth Observations from Space in 2009, seeking to outline the collective vision and aspirations of the space science community in Australia.

“Earth Observations from Space (EOS) are the single most important and richest source of environmental information for Australia. They enable a wide range of essential services to be given to the community, with multi-billion annual benefits to the nation as a whole.”¹

Paradoxically, while Australia is one of the world’s most sophisticated users of Earth Observations from Space (EOS), achieving excellent outcomes in land, water and disaster management, it is also uniquely vulnerable. The Australian EOS community relies heavily on international providers; in some cases, these facilities are fully operational and there is a low probability of failure. However, in many instances there are significant risks which are often outside Australia’s control². Australian agencies depend on space capabilities, including satellites, sensors and ground stations, which may fail, be discontinued, or simply become unavailable.³ Given the fundamental nature of the EOS data stream removal of single points of failure within this system is essential to build resilience and avoid foreseeable and cascading consequences.

Geoscience Australia’s (GA) National Earth Observation group, formerly the Australian Centre for Remote Sensing (ACRES), has been in the business of acquiring, processing and distributing satellite data since the creation of the Australian Landsat Station (ALS) in October 1979. The first formal distributor meeting of ACRES was held in November 1992. This forum continues to discuss the distribution of satellite data through the Australian spatial sector using a network of licensed distributors. The National Remote Sensing Technical Reference Group (NRSTRG) was established in 2004 by ACRES. This group represents a cross section of the remote sensing community and is made up of representatives from government, universities and private companies. Through the NRSTRG these parties provide GA with advice on technical and policy matters related to remote sensing.

The first of the Landsat satellite series was launched in July 1972 and data has been recorded over Australia by the United States Geological Survey (USGS) since then. The newest in this series of remote sensing satellites is Landsat 7 launched on 15 April 1999.

¹ *An Australian Strategic Plan for Earth Observations from Space*, ATSE 2009, p.1

² *The Status of Public-Good Remote Sensing in Australia*, Geoscience Australia, 2006

³ *An Australian Strategic Plan for Earth Observations from Space*, ATSE 2009, p.25

Australian acquisition of Landsat data began in October 1979 through the Australian Landsat Station (ALS). The ALS later became Australian Centre for Remote Sensing (ACRES) in October 1986 when it arranged for data from other satellites to be received. ACRES was integrated into GA in 2003 before being renamed the National Earth Observation group (NEO) in 2009. In this time GA has archived nearly every Australian Landsat image taken by the satellite since the establishment of ALS. GA continues to receive and archive data from the Landsat series and other satellites on a daily basis. There is a significant reliance on Landsat 5 and 7 data by local, state and national agencies⁴. Landsat 5, which originally had a design life of three years, has been providing high quality imagery for more than a quarter of a century. Landsat Data Continuity Mission (LDCM) will be launched in December 2012; while Landsat-7 continues to provide extremely stable, very well calibrated image data, many years beyond its five-year operational life expectancy. In 2003 Landsat-7 suffered the failure of the scan-line corrector, which caused some diminution of the satellite's capacity.

As part of GA's contingency plan for Landsat-5 failure the organisation is receiving as much data from the Indian Resourcesat-1 (IRS-P6) as possible. Unfortunately, because of duty cycle limitations, IRS-P6 is not able to provide reliable coverage and it is now envisaged Landsat-7 will be the primary fall-back should Landsat-5 fail.

The most optimistic estimation of the Landsat-5 lifespan calculated by the USGS is that it may last until early 2013. However, Landsat 5 has no remaining back up systems and is operating on a reduced duty cycle due to technical limitations. The impact of this is being reduced by prioritising the acquisition of images according to quality and need. Power limitations are also reducing Landsat-5's capacity to record images of Australia to southern Australia during winter months.

Geoscience Australia was appointed the Advanced Land Observing Satellite (ALOS) Oceania Data Node (ADN) for acquisition and distribution of ALOS data, a Japanese government satellite. This role ends and access to ALOS data will be limited from January 2011 after the current MOU expires. Due to policy changes GA will be considered a commercial user of ALOS data, and as a result it will not continue as the ADN and will be required to pay commercial prices for more than 50 scenes of data in any given year. There may be scope to source similar data from other space agencies, but no arrangements are in place.

National programs such as meteorology, bushfire detection and monitoring of floods, land cover, ocean and the atmosphere rely heavily on coarse resolution data streams. These are currently supplied by the MODIS sensor onboard the NASA-operated Aqua and Terra satellites. These data streams are down-linked directly by GA, BoM, the Australian Institute of Marine Science (AIMS) and the Western Australian Satellite Technology and Applications Consortium⁵ (WASTAC). Delays in follow-on missions particularly the US NPP and Joint Polar Satellite System (JPSS) missions increase the likelihood of a data gap in Australian coarse resolution applications with the current End of Life of both Aqua and Terra satellites on 30 September 2011⁶.

⁴ Phinn, S.R., Held, A. Danaher, T. and Roelfsema, C.M. (2008) *Australia's Environmental Monitoring Information Needs for a Multi-spectral, Moderate Spatial Resolution Imaging Satellite Program*. In: Proceedings of the 14th AustralAsian Remote Sensing and Photogrammetry Conference, Darwin, September 2008.

⁵ WASTAC: Bureau of Meteorology; Landgate; Curtin University of Technology; CSIRO; Murdoch University; Geoscience Australia

⁶ Earth Observation Handbook, CEOS, May 2010, <http://www.eohandbook.com/>

The cost, availability and quality of data from commercial sensors, such as the Disaster Monitoring Constellation (DMCii) and SPOT, are also being investigated. Commercial imagery products and services are used by large numbers of government agencies for environmental, national security and compliance monitoring. However, the specific purchases of each agency are not visible to other agencies, which can lead to wasteful duplication. Two states (Queensland and New South Wales) have already established commercial whole-of-state imagery acquisitions and processing to support legislated monitoring and management that have previously been completely reliant on Landsat imagery. Western Australia also has a legislative mandate for monitoring but currently the business case for using imagery has not been adopted.

Recognising the increasing role of commercial satellites, in August 2005 the Secretaries' Committee on National Security (SCNS) directed GA and the Defence Imagery Geospatial Organisation (DIGO) to establish an Inter-Departmental Committee (IDC) capable of providing advice on the use of commercial satellite technology in Australian Government. The IDC for Commercial Satellite Capabilities (IDC-CSC) met for the first time on March 10 2006 at GA. The committee is co-chaired by the DIGO and GA.

To help address some of the issues associated with commercial satellite imagery GA and DIGO are undertaking a joint project to develop a cooperative procurement panel called Optical, Geospatial, Radar and Elevation data and services (OGRE) panel. This will allow clustering between agencies at multiple levels of government, and enable such groups to access a panel of suppliers of imagery data and services.

This capability will allow:

1. development of an archive of commercial imagery at Geoscience Australia to service government;
2. development of a coordinated, streamlined and cost-effective approach to purchasing of imagery within Australian government through an active 'community of practice';
3. access to imagery under flexible licence and copyright conditions, allowing wide usage of data and imagery within all levels of government; and
4. greater governance and transparency of the usage of commercial imagery data and services within government.

3. State of Australian Earth Observations from Space

3.1 Federal and State programs dependent on EOS

The NRSTRG Drafting Group⁷ assessed current Australian Federal and State programs dependent on Earth Observations from Space (EOS). This process involved a detailed desktop study, a review of similar studies and consultation with NRSTRG attendees and distributor delegates.

This review aims to capture all programs using EOS data and includes more than three quarters of current programs within all levels of government. Defence and national security programs were not included.

35 Federal programs and 57 State or Territory programs were assessed. Federal programs ranged from the very small program run by the *Australian Electoral Commission*, rated at less than \$100 000 with a 'low' dependency on EOS (but supplying "essential" electoral data); to the three major federal programs each costing more than \$100 million: *Caring for our Country*, a \$2 billion Department of Agriculture Fisheries and Forestry (DAFF) program with a 'medium' dependency rating; the *National Carbon Accounting System (NCAS)*, accounting for greenhouse emissions from land-based activities and the National Carbon Accounting Toolbox (NCAT), operated by the Department of Climate Change and Energy Efficiency (DCCEE) and CSIRO ('high'); and the multi-agency \$273 million *International Forest Carbon Initiative (IFCI)* operated by DCCEE in partnership with the Department of Foreign Affairs and Trade (DFAT), CSIRO, AusAID and GA. This IFCI program uses satellite observations to help build capacity and support inclusion of REDD⁸ in a post-2012 global climate change agreement; and to provide details of forest extent and biomass estimation in forestry partnerships with neighbouring countries of South East Asia. This program has a high level of dependency on EOS, and contributes to numerous foreign policy, international development and environmental objectives. It is likely to expand to include coverage of most SE Asian countries in the near future.

The newly established federal government TERN (Terrestrial Ecosystem Research Network) has a \$5 million earth observation component, to deliver standardised national scale EOS products and validation sources for terrestrial environments. The marine version of this program, IMOS (Integrated Marine Observing System) is an established \$50 million program delivering physical and biological information of Australian offshore waters from EOS and in-situ measurements.

The type of data used by these programs was also considered, with 82 programs (89%) using optical data and twelve programs (13%) using radar data. 52 programs (57%) were dependent on the Landsat series of satellites and 34 programs (37%) were dependent on the MODIS sensor operating on the Aqua and Terra satellites, both of which are operated by the United States.

A defining characteristic of all programs is the *level of dependency* on EO capabilities. This was itself defined as being the practical importance of Earth observation science to the overall functioning of the program: could the program function in the absence of satellite observation? Is Earth observation an 'optional extra' to the functioning of a given program? Is remote sensing an essential component of the program?

A second defining characteristic is the *scale* of the program, stated in dollars for the life of the program as a convenient and easily compared measure. 82 of Australia's 92 programs requiring EOS (89%) fall into the 'medium' to 'high' reliance categories⁹. When considering the total value of programs involving EOS, 71 programs (77%) are valued between \$100,000 and \$10m.

While there is considerable overlap in function of the various programs, it is estimated that of the 59 programs (64%) in the 'high' dependency category, almost half are concerned with environmental issues, natural resource management, and water. Five programs each are concerned with agriculture/forestry (including IFCI), bushfires/emergencies, and mapping/planning, two with mining, and four each with forensic issues including border security, compliance, and taxation evaluation; and climate change and weather (including the Bureau of Meteorology, concerned with all aspects of national weather and climate, and being highly dependent on EOS).

⁷ NRSTRG Drafting Group, Appendix A, p 18

⁸ REDD: Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

⁹ See also *National Remote Sensing Data Requirements – Gaps and Opportunities for ACRES*, Athena Global, 2006, p.11

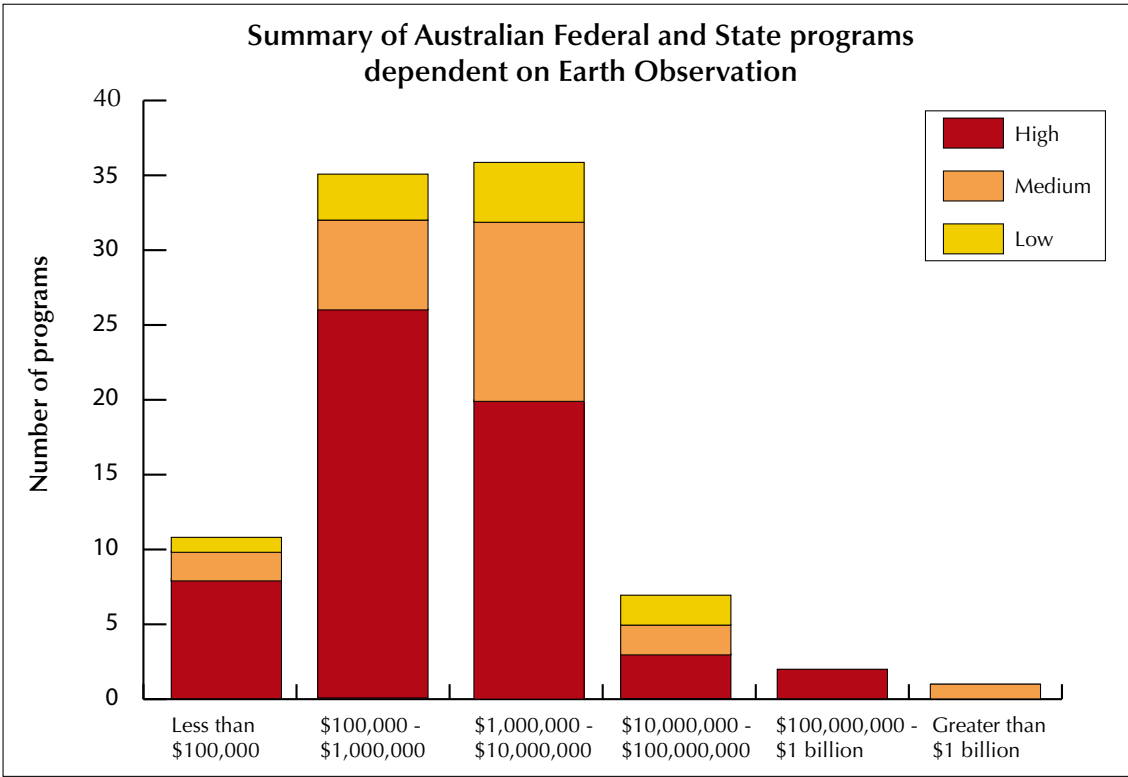


Figure 1: Australian programs dependent on Earth Observation

In the 'medium' dependency category, this pattern is repeated, with 12 of the 22 programs being concerned with environment, water and NRM, three concerned with agriculture, three with mapping and planning, two with bushfire and emergency, one with forensic/compliance and one with climate change. Notably *Caring for our Country* with a budget of more than \$1bn falls within the 'medium' category.

Summary of Australian Federal and State EO Program Spending				
Scale	Low	Medium	High	Total
Less than \$100,000	1	2	8	11
\$100,000 - \$1,000,000	3	6	26	35
\$1,000,000 - \$10,000,000	4	12	20	36
\$10,000,000 - \$100,000,000	2	2	3	7
\$100,000,000 - \$1 billion	0	0	2	2
Greater than \$1 billion	0	1	0	1
Total	10	23	59	92

Table 1: Australian Programs dependent on Earth Observation

By using the minimum of each of the scale categories and multiplying these values by the program dependency (1= High, 2/3=Medium, 1/3=Low) we can calculate a conservative minimum financial value of Earth Observation dependencies within currently active Federal and state government programs. For example, the entire IFCI program is \$273m, which puts it within the \$100m-\$1bn range; 'high' dependency means that, multiplied by one, there is a financial dependency of \$100m for the IFCI program. Using this conservative approach for all 92 programs brings the total dependency of government programs of EOS to just over \$949m.

This review can be expected to change in the future, as climate change and sea level rise assume more importance, affecting agriculture, emergency and disaster management, infrastructure, marine resources and inland water. At the same time, risks and mitigations (including the failure or reduced availability of existing systems, and their potential replacements) have been identified and are enumerated below in Section 4.2.

Results of the review are tabulated in Appendix A.

3.2 Economic assessment of EOS

In addition to this review, GA and the Cooperative Research Centre for Spatial Information (CRC-SI) have commissioned an economic assessment of the EOS field.

This review will be undertaken by ACIL Tasman to:

1. Estimate the direct and indirect economic value of space based Earth Observation activities to the Australian Community in 2008-09.
2. Determine the direct and indirect economic impact of an unplanned denial of all Earth Observation data to the Australian economy in 2008-09
3. Estimate the size of the EOS industry, particularly SME, sector in 2008-09.
4. Identify contemplated large scale government applications of Earth Observation data and estimate their direct and indirect economic value.

This economic review will be undertaken in addition to similar reviews being undertaken by the Space Policy Unit, and is intended to ensure that an economic assessment is undertaken with specific knowledge of the complexity related to economically valuing data. The direct economic value of EOS (or data more generally) may be quite small in comparison to the impact it creates because data is used for purposes other than simply its collection.

4. Seventh National Remote Sensing Technical Reference Group (NRSTRG) and distributors meeting

The seventh meeting of the NRSTRG was held in Canberra in February 2010. Present at the meeting were representatives of Geoscience Australia's *National Earth Observation Group*, private sector distributors of satellite data, operators of space infrastructure, researchers in the EOS field and high level delegates from the Federal and state agencies in the EOS field.

The NRSTRG represents a cross section of the remote sensing community and is made up of representatives from government, universities and private companies. Through the NRSTRG these parties provide GA with advice on technical and policy matters related to remote sensing.

The meeting and subsequent discussion identified a number of high level risks to the future of the EOS field in Australia, together with appropriate mitigations, and the meeting came to a series of resolutions. Recommendations, risks and mitigations are listed below.

The terms of reference of the NRSTRG are:

- to provide input to and advise on technical and delivery issues associated with reception and use of public good satellite imagery in Australia
- to provide input and advice on strategic issues concerning access to, and future requirements for, remotely sensed imagery, such as future applications and upcoming earth observation missions.

The group provides:

- advice on technical and strategic remote sensing issues in a national and international context;
- input into the development of GA strategic and contingency plans through a forum for consultation and liaison on remote sensing issues on a technical level and identification of related policy implications.

4.1 Recommendations of the Seventh NRSTRG and distributors' meeting

The seventh NRSTRG and distributors' meeting raised a list of general points of consensus; this list was developed through consultation with the drafting group and the meeting delegates. Following this consultation the following recommendations were created which reflect the consensus of the Earth observation community.

Related to **space infrastructure** the meeting recommended:

1. that Australia maintain access to an operational *moderate resolution data stream* for Australia and the region;
1. that access to an *all-weather (SAR), 24-hour operational imaging capability is ensured*; Australia is well placed for the development of new applications in this field;
2. on-going atmospheric observations to assist in the correction of imagery;
3. further cooperation to ensure that successful sensor fusion, particularly the merging of satellite and airborne datasets, will increase;
4. influencing satellite providers to ensure access to new science missions, and emphasised the importance of integrating short-term science missions into existing and new applications; and
5. developing stronger ties between civilian and defence EOS usage, particularly with reference to dual civilian/defence use of any Australian capability.

Related to **ground infrastructure** the meeting recommended:

1. urgently and substantially upgrading Australia's ground communications infrastructure and broadband networks, particularly for Near Real Time (NRT) applications such as emergency response;
2. creating stronger links between current and planned ground reception stations and working towards a national ground station network to reduce duplicate acquisitions;
3. a mechanism for working with satellite providers to coordinate the introduction of technologies such as relay satellites and virtual ground stations;
4. the development of an operational calibration and validation network based on existing sites required for EOS applications as well as to influencing future science missions; and
5. developing ongoing participation in a global initiative for standardised calibration targets

Related to **data processing** the meeting recommended:

1. moving towards national geometric, radiometric and biophysical standards to simplify inter sensor comparison to increase the resilience of EOS applications and ensuring sensor continuity;
2. recognition of the critical role of satellite calibration and derived-product validation in EOS, benchmarked against international calibration standards such as those by CEOS;
3. ensuring that national standards for EOS conform with international standards set by the international Committee on Earth Observation Satellites (CEOS);
4. adopting ANZLIC and ISO 19115-2 metadata standards as the national standard for EOS; and
5. subject to agreement by the three main Landsat processing teams (GA/CSIRO, SLATS, NCAS-CSIRO) that the Landsat Product Generation System (LPGS) be adopted as the standard processing system for the Landsat satellite series.

Related to **data delivery** the meeting recommended:

1. on improved government access to commercial EOS datasets; and
2. funding data custodianship to reduce barriers to access of EOS data including inflexible licencing, excessive pricing, usage of proprietary data formats and products delivered using specifications which limit access to expert users.

Related to **governance** the meeting recommended:

1. developing stronger links with the Intergovernmental Committee on Surveying and Mapping (ICSM) and the Intergovernmental Group on Earth Observation (GEO);
2. development of stronger links with and between major EOS players within the jurisdictions;
3. on the need to increase governance in EOS field particularly related to:
 - a. the government procurement of commercial imagery;
 - b. coordination of ground stations;
 - c. development of a national calibration and validation network and
 - d. development of standards for EOS data processing.
4. developing stronger formal links with the Australian space policy community.



Calibration and validation field work at Lake Frome during February 2009 carried out between CSIRO, Geoscience Australia, Defence Science and Technology Organisation (DSTO), the Chinese Academy of Science (CSA) and the Japan Aerospace Exploration Agency (JAXA).

4.2 Risks

4.2.1 High risk classification

Risk No.	Risk title	Detailed risk and examples	Likelihood value	Likelihood description	Consequence value	Consequence Description
1	Australian government undervaluing EOS	Australian government misunderstanding or undervaluing the role of Earth Observations from Space (EOS). For example in 2004 space R&D in relation to total government R&D was: • 17.4% United States • 11% France • 7.1% Japan • 2.3% United Kingdom • 2.3% Hungary • 0.6% Greece • 0.2% Australia Source: OECD, The Space Economy at a Glance 2007, p.40	High	This risk has already eventuated	High	Although Australia's EOS science may be world leading, Australia does not gain the same social, environmental and economic benefits as countries currently investing in EOS due to the lack of large national operational EOS programs.
2	Technical failure of operational satellite program	Inability to secure public good satellite imagery due to satellite failure. Currently 53 government programs are dependent on the Landsat series and 35 are dependent on the MODIS sensor. Landsat 5 is currently 2.4 years over its design life and Landsat 7 has some technical issues. The existing data gap before the launch of the Landsat Data Continuity Mission (LDCM) in December 2012 could lead to a break in continuity of the primary observations that 'feed' the NCAS	High	The risk of a data gap in coarse and moderate resolution sensors is substantial due to the lack of redundant programs	High	Feeds to the majority of government EOS applications would cease
3	Skills and staff shortage	Inability to source required skills and staff, for example remote sensing and image processing specialists	High	There is a high likelihood of this risk, because there are not enough students receiving high quality EO/image processing qualifications	Medium	Limited capacity to realise the potential of EO data to provide decision/policy support information
4	Poor ground infrastructure	Failure of fundamental infrastructure to service requirements, for example communications infrastructure	High	There are already instances where fundamental infrastructure is failing to meet service requirements (Alice Springs-Canberra data link)	High	The timelines of data delivery (latency) are compromised, leading to delayed delivery of data. This is a critical bottleneck during emergency response scenarios

Table 2: High level risks for the Australian Earth Observation Sector

4.2.2 Medium risk classification

Risk No.	Risk title	Detailed risk and examples	Likelihood value	Likelihood description	Consequence value	Consequence Description
5	Political constraints lead to denial of EO data	Inability to secure public good satellite imagery from foreign governments. Changes of government and/or government policy can lead to changes in data availability. For example ongoing access to the ALOS research satellite is due to end in January 2011 due to recent policy decisions in Japan	Medium	In the current economic climate government funded EOS missions are likely to be delayed or given greater commercial foci	Medium	Government funded EOS data is no longer available
6	Inability to fund commercial data	Inability to resource capture of commercial EOS data streams. The cost continental coverage from commercial moderate resolution satellites (SPOT, DMCT and similar) are quite more expensive than traditional government funded EOS data such as Landsat.	Very High	The high cost of commercial satellite imagery means that it is highly likely that the cost of Landsat equivalent (16 day revisit, continental coverage) observations will be unacceptable. Risk level is high	Medium	The EO data acquisition frequency would drop
7	Inability to access key EO data required for Australian environment	Inability to access specific sensing capabilities specifically thermal and SWIR data. These two types of data have unique sensing capabilities which are importance for understanding the Australian environment	High	These data streams are only currently available at moderate resolution from Landsat (high risk of failure and/or compromised data quality) or available from MODIS (non operational)	Medium	Many science applications for example biophysical estimates of properties such as evapotranspiration and ground cover would be severely compromised
8	Inability to source operational all-weather EO (Radar) data streams	Lack of an appropriate RADAR satellite capability. Methods cannot be operationalised without an operational data source	Medium	The current observations strategies of radar sensors do not meet operational requirements, therefore the risk is high	High	Unable to analyse an all-weather data stream for emergency and NRM purposes
9	Inability to engage new commercial EO players	EO has become more affordable particularly with the advent of micro satellites and hence the proportion of commercial satellites to public good satellites has increased dramatically. For example, while still contributing to ESA, European agencies such as DLR and ASI are driving more and more independent missions such as TerraSAR-X and COSMO-SkyMed.	High	The increased commercialisation of space is inevitable	Medium	Loss of data and reduced ability to influence new missions

Table 3: Medium level risks for the Australian Earth Observation Sector

4.2.3 Low risk classification

Risk No.	Risk title	Detailed risk and examples	Likelihood value	Likelihood description	Consequence value	Consequence Description
10	Inability to access new remote sensing technologies	New technologies such as GRACE (gravity), SMOS (microwave), DESDYN (space borne LIDAR), HypIRI (hyperspectral), and Sentinel 3 (RADAR altimetry) are fundamental to the science community, in order to develop new products to meet existing and emerging policy requirements	Low	These missions are currently planned but funding to these missions is not secure	Low	Australian EO science community loses touch with state of the art science applications
11	Severe cosmological or Electro-Magnetic Pulse (EMP) event	Due to severe cosmological event such as solar burst or EMP generated through a nuclear detonation in space access to all satellite data could cease	Very low	There are numerous EO platforms. The risk of simultaneous failure of all EO systems is slight	Very High	No access to any EO data

Table 4: Low level risks for the Australian Earth Observation Sector

4.3 Mitigations

Mitigations	Risks
Development of EOS skills in Australia: encourage/support tertiary institutions to create more EO (physics, mathematics, spatial analysis and applications of EO data) degrees which provide the fundamental knowledge, skills and experience in undergraduate and postgraduate programs. This must include industry placement in relevant organisations. Development of an appropriate education pathway in the EOS field. Attract EO/image processing experts from overseas	1, 3, 4, 7, 9, 10
Development of EOS infrastructure: invest in infrastructure to ensure that it is capable of servicing existing and future needs	1, 3, 4, 8, 10
ESA Sentinel program: seek to establish formal collaborations and ground support activities with ESA at multiple levels to ensure that data from Sentinel are available and suitable for Australian needs. Engage actively with the Sentinel-2, -3 programs.	1, 2, 5, 7, 8, 10
Influence Japanese data policy: seek to influence the government of Japan to recognise the critical need for public-good data and ensure that current and future ALOS missions are available for public-good uses and suitable for Australian needs	1, 5, 7, 8, 10
International engagement with EOS field: source public good imagery from multiple international agencies (distribute the risk). Maintain close liaison with relevant international partners and coordination mechanisms such as GEO.	1, 2, 5, 6, 7, 8, 10
Links with private sector: engage with commercial EO operators	1, 2, 3, 4, 6, 7, 8, 9, 10
NASA LDCM mission: Ensure access to comparable observations from the Landsat Data Continuity Mission (LDCM). Engage actively with the LDCM program through formal collaborations and ground support activities such as calibration and validation services	1, 2, 5, 7, 10
NASA NPP/JPSS program: Support the NASA/NOAA NPP/JPSS system development and ensure that data produced are suitable for Australian needs	1, 2, 5, 7, 10
Promote the future of EOS in Australia: Promote the importance of future science programs within international forums particularly involving the European Commission, the United States Japan and other Asian countries with active EOS programs.	1, 2, 3, 5, 6, 7, 8, 10
Study and communicate value of EOS: Ongoing analysis and communication of the size and value of the EOS field. Identify an EOS observation strategy that meets the needs of all key stakeholders and fits within the available budget	1, 3, 4, 5, 6, 7, 8, 9, 10
Take a Whole of Government approach to EOS: Identify an EOS strategy which meets the needs of all key stakeholders such as the recent international trend towards treating data as infrastructure. Support initiatives which cluster acquisition budgets to allow for negotiation of economies of scale with commercial imagery providers.	1, 2, 3, 4, 6, 7, 8, 9, 10

Table 5: Mitigations for the Australian Earth Observation Sector

Note: Risk 11 (Severe cosmological or Electro-Magnetic Pulse (EMP) event) remains untreated.

5. Appendix A. Drafting Group

The NRSTRG meeting decided that Geoscience Australia should create an initial draft of a document with the working title *The Earth Observation community's inputs to a National Space Policy*. This document was then drafted through a working group made up of:

Adam Lewis,	Geoscience Australia
Alex Held,	CSIRO
Christian Witte,	Department of Environment and Resource Management, QLD
David Hudson,	Geoscience Australia
James Cameron,	Department for Environment and Heritage, SA
John White,	Department of Sustainability and Environment, VIC
Mark Fenotti,	Department of Innovation, Industry Science and Research
Matt Adams,	Landgate, WA
Neil Bennett,	Department of Environment, Climate Change and Water, NSW
Stuart Phinn,	University of Queensland
Nick Goldie,	Geoscience Australia

6. Appendix B: Seventh NRSTRG and distributors meeting, Canberra, Friday 19 February 2010, delegates:

Australian Government delegates:

Lucy Randall	Bureau of Rural Sciences
Alexander Held	CSIRO
Gary Palmer	Defence Imagery and Geospatial Organisation
Shanti Reddy	Department of Climate Change
Michele Clement	Department of Innovation, Industry Science and Research
Mark Fenotti	Department of Innovation, Industry Science and Research
Simon Oliver	Department of Environment, Water, Heritage and the Arts
Renee Bartolo	Department of Environment, Water, Heritage and the Arts
Adam Lewis (Chair)	Geoscience Australia
Stuart Barr	Geoscience Australia
Wenjun Wu	Geoscience Australia
Medhavy Thankappan	Geoscience Australia
David Hudson	Geoscience Australia
Luke Piotrowicz	Geoscience Australia
Mike Pasfield	Geoscience Australia
Luci Knight	Geoscience Australia
Leo Lymburner	Geoscience Australia
Sandra Browne	Geoscience Australia
Rosalyn Pereira	Geoscience Australia

Jurisdictional delegates:

James Cameron	Department for Environment and Heritage, SA
Christian Witte	Department of Environment and Resource Management, QLD
Tim Danaher	Department of Environment, Climate Change and Water, NSW
Neil Bennett	Department of Environment, Climate Change and Water, NSW
John White	Department of Sustainability and Environment, VIC
David Abernethy	Land and Property Management Authority, NSW
Matt Adams	Landgate, WA
Ken Dawbin	Landgate, WA

Private sector delegates:

Max Bye	Geoimage
Rob Lees	Spot Image

Other delegates:

Gypsy Bhalla	Surveying and Spatial Sciences Institute
Stuart Phinn	University of Queensland

7. Appendix C: References and reading

- Athena Global, *Forging a National Remote Sensing Strategy*, Geoscience Australia, 2006
- Athena Global, *National Remote Sensing Data Requirements – Gaps and Opportunities for ACRES*, Athena Global, 2006
- Australian Academy of Technological Sciences and Engineering, *An Australian Strategic Plan for Earth Observation from Space*, Australian Academy of Science 2009
- Australian Academy of Technological Sciences, *A Space Policy for Australia*, AATS, 1985
- Australian Space Council, *Five-year Plan Working Group Reports*, Australian Space Office, 1994
- Chapman G., *Space A Priority for Australia*, Australian Senate, 2005
- CEOS, *Earth Observation Handbook*, ESA, May 2010, <http://www.eohandbook.com/>
- Commonwealth Interdepartmental Committee on Spatial Data Access and Pricing, *Spatial Data Access and Pricing*, AUSLIG, 2001
- Corporate GIS Consultants, *GIS/Spatial Survey Contributor's Report 2006/07*, Corporate GIS Consultants Australia Pty Ltd, 2007
- CRC for Spatial Information, *The Value of Spatial Information*, ACIL Tasman, 2008
- Department of Environment, Water, Heritage and the Arts, *Remote Sensing Business Analysis*, DEWHA, 2008
- Department of Industry, Technology and Commerce, *An Integrated National Space Program*, DITAC 1992
- Edgecombe S., *Review of the Role and Position of the Australian Centre for Remote Sensing*, Geoscience Australia, 2004
- Geoscience Australia, *Market Trends for National Mapping Division Products 2003*, Product Management Group (GA), 2004
- Geoscience Australia, *Results of Survey on Spatial Enablement of Australian Government*, Office of Spatial Data Management, 2007
- Jacobs Australia, *Inventory of Commercial Satellite Users Within Government*, Geoscience Australia, A 2008
- Lewis A., Reddy S., *The Status of Public Good Remote Sensing in Australia*, Geoscience Australia, 2006
- National Oceanic and Atmospheric Administration, *Survey and Analysis of the Asian Remote Sensing Market Aerial and Spaceborne*, Global Marketing Insights, Inc, 2007
- Phinn, S.R., Held, A. Danaher, T. and Roelfsema, C.M. 2008. *Australia's Environmental Monitoring Information Needs for a Multi-spectral, Moderate Spatial Resolution Imaging Satellite Program*. Proceedings of 14th AustralAsian Remote Sensing and Photogrammetry Conference, Darwin, September 2008.
- Senate Standing Committee on Economics, *Lost in Space: Setting a new direction for Australia's space science and industry sector*, The Senate, 2008 [and Government Response 2009]
- Sinclair Knight Merz, *Understanding Australia's Domestic Space Capabilities*, DIISR 2010
- Space IGS, *A UK Space Innovations and Growth Strategy 2010 to 2030*, Space IGS 2010
- Spatial Data Policy Executive, *Annual Report*, Office of Spatial Data Management, 2006
- Spatial Information Industry Action Agenda, *Positioning for Growth*, Department of Industry, Science and Resources, 2001
- Thackway, R., *Examples of Key User-needs*, BRS, 2010

8. Appendix D: Australian Federal and State programs dependent on Earth Observation

Total program scale refers to the total cost of the program; this includes areas of the programs which do not involve EOS. Program scale has been separated into the following classes:

Program scale
Less than \$100,000
\$100,000 - \$1,000,000
\$1,000,000 - \$10,000,000
\$10,000,000 - \$100,000,000
\$100,000,000 - \$1 billion
Greater than \$1 billion

Levels of EO dependency are defined as:

EO dependency	Description
Low	The program utilises EO data as a supplementary tool only.
Medium	The program utilises EO data and the opportunity cost of alternative data sources would increase the total scale of the program significantly.
High	The program utilises EO data and there is no economic or practical alternative.

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
1	Federal	AGD	EMA	Emergency Management Australia	Emergency Management Australia gives the Commonwealth the means to assist the States and Territories in major disasters particularly once the Commonwealth Disaster Plan is activated (COMDISPLAN). EMA has access to a range of resources used to detect, track, and mitigate emergencies, including data, images, satellite imagery, infrared monitoring, and mapping tools. EMA encourages an 'all agencies' and 'all hazards' approach to emergency management. The Australian Government is committed to supporting States and Territories in developing their capacity for dealing with emergencies and disasters, and providing physical assistance to States or Territories during an emergency.	\$10,000,000 - \$100,000,000	Low
2	Federal	DAFF	BRS, DAFF, CLUWRA, MDBA, DCCEE, DEWHA, NT DIPE, QLD DNRM, SA DW/LBC, VIC DPI, TAS DPIWE	Australian Collaborative Land Use Mapping Program (ACLUMP)	ACLUMP promotes the development of nationally consistent land-use through land use mapping coverage for Australia at both continental and catchment scale, and by developing a national information system for land management practices. ACLUMP also facilitates national technical standards, including the Australian Land Use and Management (ALUM) Classification; a national land use directory and the maintenance of land use datasets on Australian and State government data repositories; and regional and national reporting of land use and land management practices.	\$1,000,000 - \$10,000,000	Medium
3	Federal	DAFF	DAFF	Caring For Our Country	Caring for our Country is a \$2.25 billion program of the Australian Government involving high frequency large scale ground-cover monitoring. <i>Caring for our Country</i> includes six national priority areas: the National Reserve System; biodiversity and natural icons; coastal environments and critical aquatic habitats; sustainable farm practices; natural resource management in northern and remote Australia; community skills, knowledge and engagement, delivered in partnership with regional natural resources management groups, local, state and territory governments, Indigenous groups, industry bodies, land managers, farmers, Landcare groups and communities.	Greater than \$1 billion	Medium
4	Federal	DAFF	DAFF, AFMA	National Fisheries Production Database, Australian Fish Distributions and Fishing Areas	Spatial data is the key to modern fisheries management. It provides understanding where fishing takes place, how much is caught, where differing fishing methods are used, and defining and using areas of water for fisheries, closures, and marine protected areas.	\$100,000 - \$1,000,000	Low

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
5	Federal	DAFF	DAFF	National Forest Inventory	The National Forest Inventory collects and communicates information on Australia's forests. The NFI is a partnership between the Commonwealth and all State and Territory governments, and combines on-the-ground measurement with aerial and satellite technologies. It aims to provide a single authoritative source of forestry data at the national level; ensure the development of sound forest policies; ensure the viability of Australia's forest industries; and to ensure the development of effective forest conservation strategies.	\$1,000,000 - \$10,000,000	Low
6	Federal	DAFF	DAFF	National Land and Water Resources Audit	The NLWRA assessed changes in natural resources over time. The program finished in 2008. Objectives were to develop the assessment of change in natural resources as a result of government programs, using mapping technologies, Digital Elevation Model (DEM) and satellite imagery.	\$1,000,000 - \$10,000,000	Medium
7	Federal	DCCEE	DFAT, DCCEE, CSIRO, AusAID, GA	International Forest Carbon Initiative (IFCI)	The International Forest Carbon Initiative is a key Australian contribution to global action on REDD. Integration of optical and radar satellite observations will provide the necessary time-series as input to carbon accounting models and ultimately biomass estimation. L-band RADAR satellites can provide consistent observations of the tropical zone. Through the IFCI, Australia is working to help build capacity and provide momentum to support inclusion of REDD in a post-2012 global climate change agreement. A central element of the Initiative is taking practical action on REDD through collaborative Forest Carbon Partnerships with Indonesia and Papua New Guinea.	\$100,000,000 - \$1 billion	High
8	Federal	DCCEE	DCCEE, CSIRO	National Carbon Accounting System (NCAS)	The National Carbon Accounting System provides accounts for the emission and removal of greenhouse gases from land-based activities. This requires knowledge of the dynamics of carbon (for carbon dioxide and methane emissions) and nitrogen (for nitrous oxide emissions) in the landscape. The NCAS estimates emissions through a system that combines thousands of satellite images to monitor land use and land use change since 1972, updated annually; monthly maps of climate information; maps of soil type and soil carbon; databases containing information on plant species; land management, and changes in land management over time; and ecosystem modelling – the Full Carbon Accounting Model (FullCAM).	\$100,000,000 - \$1 billion	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
9	Federal	DEWHA	DEWHA	Approvals and Wildlife	Remote sensing is critical for day-to-day compliance monitoring. It is cost effective when compared to field inspection, and provides the ability to compile time series.	\$1,000,000 - \$10,000,000	High
10	Federal	DEWHA	DEWHA (Australian Antarctic Division)	Australian Antarctic Division, Australian Antarctic Data Centre	AADC is a national facility managing scientific data resulting from Australia's Antarctic scientific research program, including information about remote areas, especially Antarctica and Heard Island. It is important for core functions such as research, logistical management and keeping people safe. Key areas using remote sensing are glaciology, topographic data mapping, the sea ice atlas.	\$10,000,000 - \$100,000,000	Medium
11	Federal	DEWHA	MDBA	Basin Plan	The Basin Plan relies on comprehensive on-ground and satellite monitoring. The Water Act: specifies limits on the amount of water (both surface water and groundwater) that can be taken from Basin water resources on a sustainable basis; identification of risks to Basin water resources, such as climate change, and strategies to manage those risks; requirements that state water resource plans will need to comply with if they are to be accredited under this Act; an environmental watering plan to optimise environmental outcomes for the Basin; a water quality and salinity management plan; rules about trading of water rights in relation to Basin water resources.	\$10,000,000 - \$100,000,000	Medium
12	Federal	DEWHA	DEWHA, DAFF	National Vegetation Information System (NVIS)	The Native Vegetation Information System provides information on vegetation types in the Australian landscape. The NVIS provides land managers with up-to-date and reliable information about the extent and distribution of vegetation types, to aid in the development of long-term solutions for the Australian environment.	\$1,000,000 - \$10,000,000	Low
13	Federal	DEWHA	DEWHA, BoM	National Weather and Climate	The Bureau of Meteorology is concerned with all aspects of climate and weather. It provides information for primary producers and natural resource managers, marine and aviation services, a tsunami warning system, and specialised research activities. The BoM identifies remote sensing as the most important of all inputs into weather modelling and prediction.	\$10,000,000 - \$100,000,000	High
14	Federal	DEWHA	DEWHA	Parks Australia	Remote sensing is increasingly used for park management, for example whole of park imagery twice or three times per year.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
15	Federal	DEWHA	CBRMPA	Predictive Ocean Atmosphere Model for Australia (POAMA), ReefTEMP	Remote sensing is gaining increasing usage in reef management , for disaster impacts, reef structure, geomorphology, ecosystem functions, water quality assessments, boundary assessments, impacts of coastal infrastructure developments on coastal ecosystems	\$100,000 - \$1,000,000	High
16	Federal	DEWHA	AAD, GA, DCCEE, BoM	Satellite Altimetry	Satellite altimetry provides accurate measurements of altitude and heights , ocean heights, observation of sea-level rise, Antarctic topography, and tsunami warnings in real time.	\$100,000 - \$1,000,000	High
17	Federal	DEWHA	DEWHA, States	State of Environment (SOE)	National Environmental Information and Accounting <i>State of the Environment</i> reports provide information about environmental and heritage conditions, trends and pressures for the Australian continent, surrounding seas and Australia's external territories. The main purpose of the Reports is to provide relevant and useful information on environmental issues to the public and decision-makers, in order to raise awareness and support more informed environmental management decisions, leading to more sustainable use and effective conservation of environmental assets.	\$1,000,000 - \$10,000,000	Medium
18	Federal	DEWHA	DEWHA	Supervising Scientist Division	Remote sensing provides contextual data for scientific analysis, vegetation mapping, environmental change analysis	\$100,000 - \$1,000,000	Medium
19	Federal	DEWHA	DEWHA (ERIN)	Sustainable Environment and Water Use	Environmental Resources Information Network (ERIN) aims to improve environmental outcomes by developing and managing a comprehensive, accurate and accessible information base for environmental decisions. Information is drawn from many sources and includes maps, species distributions, documents and satellite imagery, and covers environmental themes ranging from endangered species to drought and pollution.	\$1,000,000 - \$10,000,000	Medium
20	Federal	DEWHA	CSIRO, BoM	Water Information Research and Development Alliance (WIRADA)	Evapotranspiration monitoring for regional and national scale water budgets . The science is now sufficient to allow operational monitoring of ET on a daily basis from satellites.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
21	Federal	DIAC	ACBPS	Border Protection	The Australian Customs and Border Protection Service employs satellite technology for communications, surveillance and marine rescue. Where client agencies do not have their own satellite technology capabilities, transmission of data and pictures from surveillance aircraft can be facilitated via the Customs National Surveillance Centre in Canberra.	\$1,000,000 - \$10,000,000	High
22	Federal	DIISR	CSIRO, TERN, DEWHA	AusCover TERN	The Terrestrial Ecosystems Research Network (TERN) will provide a network for terrestrial ecosystem research to coordinate national observational information and encourage research collaboration and cooperation nationally, to facilitate improved access, including by electronic means, for researchers to quality assured observational data; and to identify future needs for research and strengthen the capability of the terrestrial ecosystem community across Australia.	\$1,000,000 - \$10,000,000	High
23	Federal	DIISR	CSIRO, GRDC	Biomass Monitoring	Measurement of biomass can be made over a range of scales from point source to regional level. Satellite platforms are effective for large-scale appraisal of landscape systems, and assessment of spatial and temporal variation of vegetation across a broad area. Satellite-derived information for estimating crop production has been well established. Sensors on Landsat and SPOT provide higher resolution information making them well suited to assessing the impact of human activity on agricultural production from paddock to regional scale. Remote sensing can detect where agricultural activity is causing a shift in production potential due to changing soil quality.	\$100,000 - \$1,000,000	High
24	Federal	DIISR	CSIRO, BoM, DEWHA, DIISR	Centre for Weather and Climate Research (CAWCR)	CAWCR is a partnership between CSIRO and the Bureau of Meteorology. It is responsible for the Australian Community Climate and Earth System Simulator (ACCESS), and a number of atmosphere, weather and climate science programs.	\$1,000,000 - \$10,000,000	High
25	Federal	DIISR	CSIRO, State geological surveys, GA	International Hyperspectral Imaging Satellite Programs	Covered under international agreements such as those with ERSDAC (Japan) and GFZ (Germany). CSIRO and collaborating Australian/State government departments are using Australia for (1) establishing southern hemisphere vicarious calibration capability; (2) public geoscience information products and related (inter)national standards. >90% of current funding is provided by international partners (e.g. ERSDAC).	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
26	Federal	DIISR	AIMS	Long Term Monitoring Program (LTMP)	LTMP has been surveying the health of reefs in the Great Barrier Reef annually since 1993. This represents the longest continuous temporal record of change in reef communities over such a large scale.	\$1,000,000 - \$10,000,000	Medium
27	Federal	DIISR	CSIRO, IMOS, AIMS, DEWHA	Ocean Colour Monitoring	Large area monitoring of marine resources through ocean colour and temperature can be an effective way of defining zones of ocean and coastal regions, and taking measures relating to habitat status and changes over time. The technology may also be used for coral bleaching prediction and monitoring	\$100,000 - \$1,000,000	High
28	Federal	DIISR	CSIRO, Landgate (WA), AGRIC (WA)	Pastures from Space	Pastures from Space is a farm management tool. Satellites orbit the earth twice a day collecting the infrared response of pastures. The data is then used to estimate the rate of pasture growth during the growing season. Farmers can navigate and zoom-in to their paddocks by using map layers such as road and town names. Weekly data is also downloadable for use in estimating pasture growth rates of paddocks which can help calculate feed and livestock quantities to keep on the farm.	\$1,000,000 - \$10,000,000	High
29	Federal	DIISR	CSIRO, GSWA, GSQ, AuScope, UWA, Curtin University, Industry, GA	WA Centre of Excellence (CoE) for 3D Mineral Mapping (C3DMM)	Led by CSIRO, the five year C3DMM CoE is supported by the WA government (provides \$1 for every \$3 contributed by others to the CoE), UWA, government departments, industry and CSIRO. The main aim of C3DMM is to build capabilities that deliver publicly accessible 3D mineral mapping products from a new generation of remote sensing and drill core logging hyperspectral technologies of value to the Australian Resources sector. C3DMM is working with Australian/State geosurveys to generate new public-accessible precompetitive geoscience products of the Australian continent from a new generation of remote sensing systems (e.g. HyMap and ASTER).	\$1,000,000 - \$10,000,000	Medium
30	Federal	DRET	GA	Coastal Monitoring	The Coastal Research and Management project provides information and advice to support effective management of Australian estuaries and coastal waterways. In particular, new environmental data are acquired and compiled to establish a national overview of coastal water quality and develop agreed methods and indicators for the assessment of water quality and ecosystem integrity.	\$100,000 - \$1,000,000	Medium

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
31	Federal	DRET	GA, DFAT	LoSaMBA	The LoSaMBA project defines Australia's national maritime boundaries , advises on the definition of administrative boundaries, and advises on geoscientific aspects of the Law of the Sea. The project also involves administration and enhancement of web-based information systems, in particular the Australian Marine Spatial Information System (AMSYS); provision of specific ad-hoc advice including provision of maps, written boundary descriptions and digital data to assist Government Agencies with regulatory authority in the Australian maritime jurisdiction; support to the Office of Transport Security on the definition of Security Regulated Ports; advice to Pacific Island Countries through SOPAC on maritime boundary related issues.	\$100,000 - \$1,000,000	High
32	Federal	DRET	GA, BRS	National Land Cover Mapping	Land-cover mapping at Geoscience Australia provides a national dynamic mapping system placing current land cover status and changes in a historical context at a national, regional and local scale, and to support and facilitate a national standard baseline for change detection and environmental reporting, emergency management and aid in Natural Resource Management decisions.	\$100,000 - \$1,000,000	High
33	Federal	DRET	GA, States	National Topographic Mapping	National broad-scale operational mapping based on satellite images , captured at least annually over large areas (continental scale). Imagery is used to detect change in topographic features, and to create up to date topographic maps	\$1,000,000 - \$10,000,000	Medium
34	Federal	DRET	GA	Petroleum Acreage and Release	Development of tools and techniques for the detection of natural hydrocarbon seepage , ranging from the assessment of remote sensing applications to the geochemical analysis of sea bed samples.	\$10,000,000 - \$100,000,000	Low
35	Federal	DRET	GA, CSIRO	Pre-competitive Mineral Prospecting Research	Geoscientific surveys of Australia's mineral provinces to identify areas of new mineral potential that may be of exploration interest. Geoscience Australia markets these opportunities domestically and internationally.	\$1,000,000 - \$10,000,000	Low

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
36	Federal	DRET	G/A	Sentinel Hotspots	Sentinel is a national bushfire monitoring system , which allows users to identify fire locations where there is a potential risk to communities and property. Sentinel obtains data from satellites which orbit the Earth collecting data in a path 2330 km wide, at least once a day. The data is received by Geoscience Australia's Data Acquisition Facility at Alice Springs. Locations of high temperature are identified and extracted to a small text file and transmitted from Alice Springs to Canberra where they are fed into a spatial database. From there, the data can be queried and added to dynamically-created maps using a web-based mapping system.	\$100,000 - \$1,000,000	High
37	Federal	PM&C	AEC	Electoral Mapping	Satellite imagery provides essential data to the Australian Electoral Commission for establishing and monitoring electoral boundaries to household level.	Less than \$100,000	Low
38	Jurisdiction	ACT	ACTPLA	ACT Planning and Land Authority	Satellite imagery used for land use monitoring , mapping, catchment management, bushfire detection and management	\$100,000 - \$1,000,000	High
39	Jurisdiction	ANZLIC	ANZLIC	DEM and Surface Modelling	The National Elevation Data Framework (NEDF) is a collaborative framework that can be used to increase the quality of elevation data and derived products such as digital elevation models (DEMs) describing Australia's landform and seabed. The aim is to optimise investment in existing and future data collections and provide access to a wide range of digital elevation data and derived products to those who need them.	\$1,000,000 - \$10,000,000	High
40	Jurisdiction	NSW	DECCW	DustWatch	The DustWatch Program monitors aerosols , focusing on dust, across southern Australia using field monitoring stations, and MODIS derived groundcover, fire and dust	\$100,000 - \$1,000,000	High
41	Jurisdiction	NSW	Department of Planning & Local Government & Shires Associations	Electronic Housing Code Pilot (EHC)	e-Planning . The EHC is focussed on developing and demonstrating a shared, integrated platform for the online and end-to-end processing of residential housing development applications under the NSW Housing Code. Funded under the Commonwealth Housing Affordability Fund.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
42	Jurisdiction	NSW	DECCW	Elevation and vegetation structural mapping	Wetland and water resource management are programs which make use of ground surface elevation. Vegetation structure derived (from Lidar) is increasingly used as in a variety of programs including vegetation mapping & fire modelling	\$100,000 - \$1,000,000	High
43	Jurisdiction	NSW	DECCW	Groundwater Dependent Ecosystems (GDE) Water Balance	Groundwater dependant ecosystem location mapping and hydraulic modelling (eg evapotranspiration levels) undertaken by the NSW Office of Water.	Less than \$100,000	High
44	Jurisdiction	NSW	DECCW	Groundwater Quality and Coastal GDE Mapping	Mapping of coastal groundwater dependant ecosystems (GDE) as inputs to catchment hydraulic & water balance modelling.	Less than \$100,000	High
45	Jurisdiction	NSW	DECCW	Inland wetland inventory and monitoring	The Inland Wetland Inventory is a storehouse of standardised information on wetlands in a management area. Inventory data may be generated from available data sources (tenure, climate, population, land use etc) or collected through surveys (flora, fauna, water quality etc) involving the use of field observation and satellite imagery.	Less than \$100,000	High
46	Jurisdiction	NSW	DECCW	Mapping Wetland Inundation Histories for Iconic NSW Wetlands	Mapping wetland inundation histories for adaptive management of environmental water	\$100,000 - \$1,000,000	High
47	Jurisdiction	NSW	DECCW	Marine Monitoring Reporting and Evaluation	Chlorophyll estimates are required to support reporting against NSW natural resources management marine targets	Less than \$100,000	High
48	Jurisdiction	NSW	OOW	Monitoring: State of the Catchments	The NSW Office of Water is responsible for measuring and reporting on progress towards state-wide targets for rivers and groundwater. These targets are: by 2015 there is an improvement in the condition of riverine ecosystems; by 2015 there is an improvement in the ability of groundwater systems to support groundwater dependant ecosystems and designated beneficial uses. Catchment and riverine vegetation monitoring by satellite imagery are extensively used.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
49	Jurisdiction	NSW	DECCW	NSW High-Resolution Vegetation Monitoring Program	The High-Resolution Program complements the SLATS (Landsat) Program and enables monitoring and reporting of vegetation extent change to about 5% crown cover using scientifically developed and tested methods. These combine field verification and computer processing using state-of-the-art remote sensing and Geographic Information System (GIS) technologies. This imagery is also used for state wide native vegetation mapping. Short term mapping priorities include the Hunter and the Central Western regions of NSW.	\$10,000,000 - \$100,000,000	High
50	Jurisdiction	NSW	DECCW	NSW Woody Vegetation Monitoring Program (NSW SLATS)	SLATS (Moderate resolution eg Landsat) is a major vegetation monitoring initiative to investigate the overall cover of woody vegetation , and to report on the previously unquantified extent of land clearing in NSW using scientifically developed and tested methods. This program uses similar approaches to the NSW High-Resolution Vegetation Monitoring Program.	\$1,000,000 - \$10,000,000	High
51	Jurisdiction	NSW	DECCW	Rural Floodplain Management	Remote sensing is an essential component of rural floodplain management. Data is used to determine floodways and flooding, map vegetation communities and delineate floodplain habitats.	Less than \$100,000	High
52	Jurisdiction	NSW	DECCW/Industry	Sea Surface Temperature and Height Anomaly	Mainly Hydraulics Laboratory provides access to sea surface temperature products , and a range of other satellite derived ocean products from CSIRO that receives data from a number of environmental satellite instruments including MODIS, AVHRR and SeaWiifs.	Less than \$100,000	High
53	Jurisdiction	NSW	LPMA	Topographic Mapping Program	Mapping topographic features to meet the requirements of the State of NSW for this type of Spatial Data Infrastructure (SDI). This program utilises satellite imagery for the Western Division of NSW and airborne imagery for the Central and Eastern Divisions of NSW.	\$1,000,000 - \$10,000,000	Medium
54	Jurisdiction	NSW	LPMA	Valuation for Taxation Purposes	Using imagery for taxation valuation purposes. This program utilises satellite imagery for the Western Division of NSW and airborne imagery for the Central and Eastern Divisions of NSW.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
55	Jurisdiction	NSW	DECCW	Vegetation Monitoring – Grassland	A range of satellite derived vegetation indices have been widely used to classify land cover , estimate crop acreage, and detect plant stress. The National Oceanic and Atmospheric Administration (NOAA) produces global estimates based on the reduced resolution Global Area Coverage (GAC) data from the NOAA orbiting satellites.	\$100,000 - \$1,000,000	High
56	Jurisdiction	NSW	LPMA	Western Lands Monitoring and Compliance	Managing the Crown Estate in Western Division for Leasehold Tenure land managers	\$1,000,000 - \$10,000,000	Medium
57	Jurisdiction	NSW / VIC	BF CRC	Grasslands curing assessment	Satellite derived vegetation indices may be used to quantify vegetation condition. These indices use a combination of wavelength bands to highlight specific features of the vegetation. The most common of these is the Normalised Difference Vegetation Index (NDVI) that is sensitive to vegetation chlorophyll content and cover. The NDVI has been used to map various characteristics of vegetation such as biomass, vegetation health and phenological stage. It is this latter application that makes the index of particular interest in the area of grassland curing.	Less than \$100,000	High
58	Jurisdiction	NSW, Vic, Qld, SA	CRCSI / LPMA / UNSW	Radar Watch	Radar Watch is a research demonstration program to promote radar EO in partnership with agencies from Europe (including ESA, e-GEOS and Infoterra), Japan and China. Radar Watch includes a range of targeted application modules such as Mine Watch for mapping mine subsidence, City Watch for monitoring urban subsidence due to groundwater extraction and underground construction, Earthquake Watch for detecting co-seismic ground deformation, Bushfire Watch for supplementing optical and infrared EO, and Flood Watch for all-weather as well as day and night observations.	\$100,000 - \$1,000,000	High
59	Jurisdiction	NT	NTLIS, NREA	Rangeland monitoring	Remote sensing is the primary means of monitoring natural resource management in the Northern Territory.	\$100,000 - \$1,000,000	High
60	Jurisdiction	NT	Bushfires NT	Fire mapping: National Parks and Anhem Land Fire Management Area	Satellite imagery plays a vital role in bushfire containment and management , particularly in the very large areas of the Gulf Country and inland areas of the Territory. One example of this is the Indji Watch hotspot system.	\$100,000 - \$1,000,000	High
61	Jurisdiction	QLD	DERM	Biomass monitoring	It is now practical to measure above-ground biomass of woody vegetation from certain RADAR satellites	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
62	Jurisdiction	QLD	DERM	Groundcover monitoring	Land managers, pastoralists, policy and planning staff can make important management decisions based on satellite derived information on groundcover	\$100,000 - \$1,000,000	High
63	Jurisdiction	QLD	DERM	QLUMP land-use program	Queensland Land Use Monitoring Program (QLUMP) mapping is performed according to the Australian Land Use and Management Classification (ALUM). The methodology is fast, reliable and accurate, and makes the best use of available databases, satellite images, and aerial photos	\$1,000,000 - \$10,000,000	High
64	Jurisdiction	QLD	DERM	Queensland Wetland mapping and Classification	The Queensland Wetland Mapping and Classification project provides a comprehensive coverage of wetlands , mapped at a scale and level of detail that can guide the implementation of management actions and support management decision-making. It is also part of a larger project involving the development of a wetlands inventory database. The water body mapping for Queensland has been completed using satellite imagery, combined with other data sources to form the water body layer of the final wetlands mapping product.	\$1,000,000 - \$10,000,000	High
65	Jurisdiction	QLD	DERM	Reef Catchment Monitoring (RCM)	Reef Catchment Monitoring to characterise land use, gully erosion and the extent of riparian vegetation. The baseline data is to be updated in five years or earlier.	\$1,000,000 - \$10,000,000	High
66	Jurisdiction	QLD	DERM	Regional ecosystem mapping	Regional ecosystem maps describe the extent and conservation status of remnant vegetation as regional ecosystems. They provide information crucial to the preparation of an application to clear vegetation, particularly for developing a property vegetation management plan.	\$1,000,000 - \$10,000,000	Medium
67	Jurisdiction	QLD	DERM	Soil exposure assessment	Land degradation problems persist in large areas of rural and regional Australia. Generally, these problems have resulted from a trial and error approach to land management, and the imposition on the Australian environment of agricultural systems that have significantly altered hydrology and soil properties, and have caused a loss of biodiversity. Satellite imagery and remote sensing are important to monitor and remediate these areas.	\$1,000,000 - \$10,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
68	Jurisdiction	QLD	DERM	Statewide Landcover and Tree Study (SLATS)	SLATS is a major vegetation monitoring initiative to investigate the overall cover of woody vegetation, and to report on the previously unquantified extent of land clearing in Queensland using scientifically developed and tested methods. These methods combine field verification and computer processing using state-of-the-art remote sensing and Geographic Information System (GIS) technologies	\$10,000,000 - \$100,000,000	High
69	Jurisdiction	SA	DWLBC	Imagery Baseline Data Project		\$100,000 - \$1,000,000	Low
70	Jurisdiction	SA	DWLBC	Statewide Native Vegetation Detection	The Statewide Native Vegetation Detection project created a classification of land cover from 2004 Landsat imagery into seven classes which included one class to represent woody native vegetation. The project verified DEH's existing woody native vegetation mapping data in the agricultural regions for the years 1990, 1995 and 2004. Verification work identified where woody vegetation mapping was incorrect based on clearance	\$1,000,000 - \$10,000,000	High
71	Jurisdiction	TAS	DPIW	TASVEG	TASVEG was produced by the Tasmanian Vegetation Mapping and Monitoring Program (TVMMP). Aerial photographic interpretation (PI) is the primary data collection method with field verification of representative polygons accounting for approximately one quarter to one fifth of vegetation mapping time. The most recent photographs are used where possible. High resolution satellite imagery may be used, where available, for capture and interpretation of features.	\$100,000 - \$1,000,000	Medium
72	Jurisdiction	VIC	DSE	Bushfire areas and tree cover	Remote sensing is the most practical method for mapping and quantifying fire impacts at landscape scales. Sensors on board earth observation satellites or other platforms measure the radiation emitted and reflected from the earth surface at distinct wave-length.	Less than \$100,000	Medium
73	Jurisdiction	VIC	DPI	Evapotranspiration modelling	Evapotranspiration of irrigated pastures remotely sensed vegetation index and thermal data are combined at the individual paddock scale to model the ET of irrigated pastures.	Less than \$100,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
74	Jurisdiction	VIC	DPI, DSE	Land use	Victorian land-use has been monitored from regional to paddock scale. Agricultural land uses were determined through an automated process to spatially allocate the agricultural census data using satellite imagery, using a method described as SPREAD (Walker & Mallaachchi 1998).	\$100,000 - \$1,000,000	High
75	Jurisdiction	VIC	DSE	Native vegetation extent and condition	Remote sensing is an essential component of native vegetation monitoring. The health and revegetation of native vegetation is vital to the natural processes that we rely on for clean air and water, for natural heritage	\$100,000 - \$1,000,000	Low
76	Jurisdiction	WA	Landgate	Agimage – SW of WA	Agimage provides land management professionals access to satellite maps and an extensive archive of biomass images since 1993 covering Western Australia's South-West, used at paddock level to determine variations in crop growth. Farmers and land management professionals can use this information at large paddock scale to estimate crop yield and pasture growth rates, and to forecast potential crop yield.	\$100,000 - \$1,000,000	High
77	Jurisdiction	WA	Landgate	CarbonWatch	Landgate is developing a suite of online carbon accounting tools , designed specifically for forest carbon sink projects. CarbonWatch is aimed at making it easier for project owners to plan, monitor, quantify and report on carbon sequestration projects.	\$100,000 - \$1,000,000	High
78	Jurisdiction	WA	Landgate, FESA	Emergency management	Operational staff use the Shared Land Information Platform Emergency Management (SLIP-EM) services to assist decision making during incidents. The WA emergency management community in collaboration with strategic information providers (i.e. Bureau of Meteorology, Landgate and others) collaborated in the development of SLIP-EM to ensure each agency is able to effectively share authoritative and current spatial information.	\$1,000,000 - \$10,000,000	Medium
79	Jurisdiction	WA	DEC	Fire Mapping and Modelling	The mapping and locations of fire patterns within the DEC Estate. Information on precise fire boundaries, burn intensities and occurrences are vital for fire management and understanding	\$100,000 - \$1,000,000	High
80	Jurisdiction	WA	Landgate	FireWatch Program	Satellite imagery is an important component of fire management. The FireWatch map service provides emergency services personnel with an online map application to help in the management of bush fires over Australia. Datasets include fire hotspots, burnt area maps since 1997, greenness images updated daily and weekly, lightning data and other useful map layers.	\$100,000 - \$1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
81	Jurisdiction	WA	Landgate	FloodMap Program	FloodMap provides emergency services personnel with datasets and an online map to help in the management and mitigation of floods over Australia. Datasets include current surface water derived from MODIS, historical flooding, flood risk products, soil moisture from AMSRE, soil moisture saturation index and profile available water from MTSAT	\$100,000 - \$1,000,000	High
82	Jurisdiction	WA	DEC	Land Audit and Compliance	Audit and compliance of native vegetation. Appropriate image sets are sighted to checked native vegetation compliance with appropriate applications. Major focus has been within the SW but development occurring to the rest of the State.	Less than \$100,000	Medium
83	Jurisdiction	WA	Landgate, CSIRO, DEC, DAFWA, DoW, DPI	Land Monitor Project - SW of WA	Land Monitor is a coordinated initiative originally under the National Dryland Salinity Program. The project originally aimed to systematically monitor salt-affected land and remnant vegetation change over the agricultural area of south west of Western Australia. Land Monitor phase III is aimed at vegetation monitoring on an annual bases across the SW of WA.	\$100,000 - \$1,000,000	Medium
84	Jurisdiction	WA	DEC	Marine Mapping and Monitoring	Monitoring, with evaluation and reporting, is the key feedback mechanism in a 'best practice' natural resource adaptive management approach. Hence, it is primarily the responsibility of management agencies. Monitoring, for measuring success of management actions towards objectives (of Marine Protected Areas management plans and marine fauna conservation programs) and for applying active adaptive management principles to marine conservation, will be a priority for WA's marine science program.	\$1,000,000 - \$10,000,000	Low
85	Jurisdiction	WA	DOW	Monitoring Groundwater Decline	The Land Monitor Project produces maps based on Landsat data of the extent and recent (~10 year) change in areas of salt-affected/persistent low productivity land. Spatial resolution is 25 m by 25 m. The project covers the entire SW agricultural area (24 million hectares). Accuracy assessments of salinity mapping are carried out and published for sample areas within each region.	\$1,000,000 - \$10,000,000	High
86	Jurisdiction	WA	Landgate	OceanWatch Program	OceanWatch provides access to sea surface temperature, optical attenuation, and chlorophyll products and in the future, a range of other satellite derived ocean products.	\$100,000 - \$1,000,000	High

Prog ID.	Type	Lead portfolio	Agency/s	Program/Product Name	Description	Total program scale	EO dependency
87	Jurisdiction	WA	Water Corporation	Urban Monitor	The Perth Water Corporation is a partner agency in collecting high resolution multi-spectral imagery over greater Perth metro area for range of analyses options	\$100,000 - \$1,000,000	High
88	Jurisdiction	WA	Water Corporation	Vegetation Monitoring	Land Monitor products are used to gain understanding on vegetation dynamics and its effect on water yield in Perth dam catchments	\$100,000 - \$1,000,000	Medium
89	Jurisdiction	WA	Water Corporation	Vegetation Monitoring and cover estimates	High resolution airborne multi-spectral imagery are used to evaluate change in forest cover and effectiveness of forest management to increase water yield from Wungong Catchment	\$100,000 - \$1,000,000	High
90	Jurisdiction	WA	DEC	Vegetation Monitoring,	Key DEC responsibilities include broad roles in conserving biodiversity and protecting, managing, regulating and assessing many aspects of the use of the State's natural resources. Many operational tasks require ongoing accepted monitoring procedures that use consistent, repeatable imagery.	\$100,000 - \$1,000,000	High
91	Jurisdiction	WA	Landgate	VegetationWatch Program	VegetationWatch produces greenness image maps over Australia. MODIS and NOAA satellite images are processed to provide greenness images at 250m and 1km resolution. Greenness images from MODIS are available within 3 hours of the overpass and a fortnightly composite over Australia is available weekly.	\$100,000 - \$1,000,000	Medium
92	Jurisdiction	WA	Landgate	WALIS	WALIS is a partnership of government agencies working with business, education and the general community to manage and promote the State's geographic information. Data captured through the State Land Information Capture Program (SLICP) can range from aerial photography, topographic data, satellite imagery, bathymetry, LIDAR, infrastructure, to 3D surveys, soils, ortho-imagery and any other type of spatial data required. The data requested through SLICP provides an opportunity to drive decision making on important issues such as climate change, planning, mining and health. Landgate has both simplified the SLICP process and is seeking to expand the capabilities and funding of SLICP to address the future needs of the state's land and spatial information.	\$1,000,000 - \$10,000,000	Medium

