



Australian Government
Geoscience Australia



Digital Earth
AUSTRALIA

Program Roadmap

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1 Introduction

1.1 Background

Digital Earth Australia (DEA) is an Australian government program that turns routine, reliable and robust satellite data into decision-ready information about Australia's natural and built environments. This information helps governments and industry better understand soil and coastal erosion, the impact of land management practices, deforestation, urban development, and water quality and availability.

DEA enables the processing, interrogation and presentation of Earth observation data in response to the government's priority information needs; for example, carbon farming opportunities, agricultural productivity, land use, and forest cover in Australia.

DEA supports Australia's developing digital economy by providing businesses with access to reliable, standardised satellite data that can be used to build new algorithms and applications for commercial purposes. This helps generate new jobs and commercial opportunities, particularly in small to medium sized enterprises where such data was previously out of reach.

DEA provides a series of structures and tools that calibrate and standardise datasets, enabling the application of time series analysis and the rapid development of quantitative information products. It uses open source standards and is designed to help both government and private industry make informed decisions.

DEA supports Australia's Earth observation community to achieve some of the broader goals outlined within the *Australian Earth Observation Community Plan*¹ and *2026 Spatial Industry Transformation and Growth Agenda*,² both of which explicitly reference the need for digital infrastructure to support industry growth, and note the importance of DEA as a key platform.

The programs also collaborates with National Research Infrastructure facilities (including the proposed Earth Observation Facility) to ensure they deliver capabilities that can transition into operation through Digital Earth Australia.

DEA benefits government departments and agencies that need accurate and timely spatial information on the health and productivity of Australia's landscape and provides Australian industry with access to stable, standardised data from which it can innovate to produce new products and services.

DEA creates opportunities for small to medium enterprise, particularly in the development of applications that can improve agricultural productivity, and provide more efficient tools for environmental accounting and monitoring.

The DEA program delivers robust data infrastructure and information products that:

1. increase the efficiency and effectiveness of Australian government programs and policies; and
2. enable Australian business to quickly capitalise on open data, and create new capabilities to increase efficiency, productivity and employment opportunities.

¹ <https://www.eoa.org.au/aeocp-the-plan/>

² <https://2026agenda.com.files.wordpress.com/2016/10/2026-agenda-ideas-v1-9-for-release.pdf>

1.2 Looking Ahead

While the DEA program (and this roadmap) is intentionally focused on the building blocks of future capability, i.e. those projects which are currently underway, and those which are on the horizon, it is important that the program maintain a view beyond the horizon that is both ambitious and formative.

To ensure it remains relevant and continues to deliver value, DEA must keep pace with the rapidly growing demand for information, the expanding capabilities of observation platforms, and evolution of integrative data-rich science. These developments will push the boundaries of current technologies and thinking about how DEA and Earth observations can be used to address national and global environmental challenges.

The long-term goal of most Earth monitoring is environmental forecasting. To achieve its full potential, DEA must aim to provide a forecast; the ability to advise on “*What will happen if...?*”, as we do for the weather, the climate, national revenues and expenses, and global populations. The establishment of a meaningful forecast for land and water provides a focus for the longer-term direction of DEA. Over time, DEA will move from characterising and detecting changes to the Earth’s surface, through to modelling and prediction. With this aim in mind, several development fronts are implied:

- DEA must be ‘future ready’. A conceptual framework that accommodates observations and modelling will allow the development of DEA to be guided by longer-term considerations as well as deliver specific products to meet immediate needs. Importantly, this framework will need to be developed in partnership with the wider science and research community.
- Characterisation, i.e. quantifying the state at a particular point in space and time, must become spatially and temporally seamless. DEA must be able to be queried at any arbitrarily nominated place and time, with quantitative estimates of uncertainty. Interpolation and estimation methods will be essential building blocks.
- Models of the behaviour of places (or objects) will be needed so that their future state can be predicted. Initially, these models will be statistical; for example the central tendency and the seasonal variation. But in Australia, where episodic events such as rainfall, wind and heat, drive our landscapes so strongly, additional co-variates (elevation, evaporation, rainfall, elevation, soil characteristics, terrain position for example) will be needed for even these empirical models to perform well.
- Process knowledge, that is models that incorporate a knowledge of process, will be increasingly called for. Examples of process models may include factors that lead a waterbody to be turbid, or a pasture to grow. A pathway will be needed to evolve statistical models into increasingly process-aware representations. This is a key challenge for the conceptual framework

The program will explore technologies such as machine learning and AI methods to generate new foundational products that will empower scientists, government agencies, and industry to generate their own applications and bespoke analytics.

Internationally, the program will look to ensure that DEA helps Australia influence key global agendas such as the Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction and the Paris Climate Accord.

1.3 Purpose

This document describes the high level workplan for DEA. It is a living document that will be regularly updated.

DEA is a highly collaborative program that is seeking opportunities to work with others to generate value to its stakeholders. The program's approach is to test ideas through innovation and rapid production of new beta products and capabilities. Not all endeavours produce viable outcomes and the program follows an iterative approach: small, smart steps; pause and learn; then build those lessons into the next stages, or halt development if required.

Working across such a broad domain with so many opportunities to choose from, DEA necessarily structures itself in a way that encourages staff to test ideas, explore and innovate to identify opportunities to meet particular stakeholders' needs. This document has been designed to promote and support this approach and send a clear message DEA staff and stakeholders alike that we want to hear about good ideas, and will act on them quickly when the opportunity arises.

This roadmap communicates the broad areas in which DEA sees opportunity to derive valuable insight for its stakeholders. Within each of these broad areas it will outline the current projects as well as priorities we see on the horizon. This approach allows the program to adapt to changing circumstances rather than being bound to a preconceived plan. Given the deliberately incomplete nature of the document, it will be updated on an ad-hoc basis as required.³

2 Projects

The projects listed in the following section represent a high level summary of those areas of activity in which DEA is currently investing resources and development effort. In keeping with the program planning approach, these projects are a snapshot of current priorities as defined by the program with input from its users, partners and Interdepartmental Committee.

This view of the program is subject to change as priorities shift in response to Australian government and industry requirements, advances in technology and relationships with the international satellite operators and data providers that support the Australian Earth observation community.

The section is divided into broad areas of focus (e.g. Land Cover and Land Use, Marine and Coastal, and Data Management) and further subdivided into Current and On the Horizon projects. The Current projects are those development efforts to which the program has presently allocated resources. The On the Horizon projects are potential areas for research and development that have not yet been allocated resources and have yet to be prioritised by the program.

³ Initiatives in the Current Projects sections of the Roadmap are those being actively worked on in the current Program Increment (12-week period). Those in the On the Horizon sections are intended to provide a sense of potential future activity, but are indicative only and are not a definitive schedule for upcoming program increments. Projects may occasionally move between current and horizon states as priorities and activity shifts between program increments.

2.1 Product Development Approach

The DEA Program takes an Agile, user-centric approach to development that aims to ensure each product or service developed by the program has a practical, real-world application that will enable positive business change for its users.

Idea

A product idea exists when DEA staff and/or stakeholders have an idea of how they might be able to gain further insights from Earth observation data. DEA staff and stakeholders are constantly engaging with new problem spaces. A product idea usually results from direct engagement with a potential user from outside the program, or from exploratory research.

Concept

A product concept is effectively a refined and tested product idea. This is the point at which at least one potential user has been consulted to work out what the product would look like in order to be useful. The product concept expands on the product idea by clearly identifying an initial product outline and user profile.

Prototype

The product prototype represents the first, minimum viable product version of the newly developed concept. A beta product will be produced and iteratively improved in consultation with potential users to ensure any major issues are resolved before the product is officially published and routinely produced.

Operational

The operational product is the published version of the product prototype. This is the point at which all systems required to routinely produce the product are up and running. Products that are available to users through NationalMap (www.nationalmap.gov.au) are listed at Appendix 1 along with other products that are accessible from the National Computational Infrastructure's (NCI), and DEA's cloud-based distribution service.

Insight

DEA measures its value in terms of the improvements we have enabled in the decisions, policies and programs of others.

Insight is the point at which DEA's products are embedded into business systems and processes to enable users to gain insights relevant to their activity, and resultantly make more informed business decisions. Often this stage will involve DEA staff collaborating directly with organisations and users to help them to embed DEA products into their business systems and processes. This is the point at which DEA's products generate real value for users, and is the how the program will measure its success.

Refinement

This ongoing phase of the product development cycle involves continuing to work with users to understand how products could be better and to ensure that the positive business changes enabled by the product are maximised, captured and promoted.

2.2 Users

Users (or end-users) are the individuals or organisations that ultimately use, or are intended to use, the products and services produced by the DEA program. In the initial stages of product development users may be represented by an archetype or hypothetical 'typical user' until a definitive user is identified. All DEA products are designed with a user in mind.

2.3 Partnerships

In cases where a user has identified the need for significant customisation or assistance to successfully embed a DEA product in its business processes, DEA may establish a project partnership. Project partners work with DEA to co-design the final product, generate support for it within their organisation, and to identify and communicate the positive business change enabled by the newly developed capabilities. Project partners invest their own time and expertise in the project in order to ensure that the DEA products will provide tangible benefits.

2.4 Interdepartmental Committee

The DEA Interdepartmental Committee (IDC) is composed of senior representatives from eight Commonwealth Government entities. The IDC assists the program in setting a strategic direction that aligns with the Australian Government's agenda and achieves the desired benefits for the Australian Government. The IDC members provide strategic insight into both the broader political landscape and specific programs within their departmental portfolios that could benefit from the application of spatial information and the DEA.

IDC members have been quick to see the value in the program for their respective portfolios and will likely have one or more Project Partners within their organisation working collaboratively on DEA projects. The IDC plays a dual role of advocating for new projects from within their portfolio areas and advocating the potential of DEA across government.⁴

⁴ Projects in the Current Project sections are given a scale of Small, Medium, or Large. This scaling is an estimate based on the project's complexity, time frame, and resource requirements. The scale is indicative only and based on an understanding of the project requirement at the time the project is initiated. This scale may change over time as the project scope expands or is reduced (e.g. following completion of a particular phase of the project).



3 Land Cover and Land Use

Land cover is the observed biophysical cover on the Earth's surface including trees, shrubs, grasses, soils, exposed rocks and water bodies, as well as human elements such as plantations, crops and built environments. Earth observation data recorded over a period of time allows the observation of land cover dynamics. Classifying these responses provides a robust and repeatable way of characterising land cover types.

Land use information shows how our land resources are used. This includes the production of goods (such as crops and timber) and services (such as defence, recreation, biodiversity and natural resources protection).⁵ Land uses have a major effect on Australia's natural resources through their impacts on water, soil, nutrients, plants and animals. There is also a strong link between changing patterns of land use and economic and social conditions, particularly in regional Australia.

The ability to detect change in the landscape is essential for land accounting, environmental reporting and modelling applications, including modelling of climate change, erosion risk, natural hazards and carbon dynamics.

Satellites orbiting the Earth are uniquely positioned to make routine observations of a variety of physical characteristics over very large geographic areas and over extended periods of time. The scale of these observations is such that they cannot be provided as effectively and efficiently by aircraft or unmanned aerial vehicles or in-situ systems such as ground-based observatories.

State and territory governments have similar but differentiated needs for monitoring of the land cover. Each state and territory has legislation and regulation that is predicated or specifically requires forms of land cover mapping. While the classes of land cover and the uses for land cover will differ between jurisdictions and according to uses, the underlying approaches and measurements that enable this work share a high degree of commonality.

The provision of a national, medium resolution (10 m – 30 m) land cover product that is both consistent and updated on a regular basis fills several needs at the state, federal and international levels. Monitoring land cover nationally is a key requirement for several agencies in environmental reporting. It is one of several inputs to the National Land Accounts (with land value, land tenure, and land use); it is required for carbon accounting, the monitoring of tree clearing and environmental protection; it is required for agricultural monitoring and forecasting, water monitoring, and government Economic and Environmental Accounts. More broadly, land cover is a key input to State of the Environment reporting and can provide critical information for monitoring Sustainable Development Goals indicators such as desertification, land degradation and drought.

To develop a comprehensive land cover suite, DEA works with Australian Government partners, such as the Department of the Environment and Energy, and Earth observation community groups, such as Earth Observation Australia and the Earth Observation for Government Network to engage state and federal stakeholders to find agreed inputs to a national product. The national product will include existing products where appropriate, and build new contributing products in collaboration with the

⁵ <http://www.agriculture.gov.au/abares/aclump/land-use>

stakeholders. DEA provides the mechanism to be the custodian of the processing and operational delivery of national land cover as well as develop products that help to achieve the required consistency and standards for national level monitoring and reporting.

3.1 Current Projects

3.1.1 Near Real Time Water Observations from Space, Sentinel-2

Project	Working with	Scale
Water Observations from Space Sentinel-2		Medium

DEA is developing a near-real-time (NRT) Water Observations from Space (WOfS) product based on Sentinel-2 data. WOfS allows users to understand the location and movement of water present in a landscape. A component of this project includes testing the quality and reliability of the classification and output of the NRT data.

A Sentinel-2 based WOfS product will feature a much improved temporal and spatial resolution over previous Landsat-based products. Water information will be made available in near-real-time and can be used for environmental monitoring, flood mapping, monitoring planned water releases, and management of water resources in highly regulated systems.

3.1.2 Sentinel-2 Fractional Cover

Project	Working with	Scale
Sentinel-2 Fractional Cover	University of Queensland, Cibo Labs	Medium

DEA is working on the production of a near-real-time (NRT) fractional cover (FC) product based on Sentinel-2 data. For each date that a clear NRT Sentinel-2 scene is available, a corresponding FC classification will be created that represents the proportion of the land surface that is bare, covered by photosynthetic vegetation, or non-photosynthetic vegetation.

The FC product allows users to understand the large scale patterns and trends and inform evidence based decision making and policy on topics including wind and water erosion risk, soil carbon dynamics, land management practices and rangeland condition.

3.1.3 National Land Cover Project

Project	Working with	Scale
National Land Cover Classification System (LCCS)	University of Aberystwyth, ABS, DAWE, CSIRO	Large

This product extends a successful trial implementing the United Nations Food and Agriculture Organisation Land Cover Classification System, to provide annual, continental land cover and land cover change for Australia at the 30m scale. The land cover product will be produced annually and provide information on surface water, terrestrial and aquatic vegetation, cropping and urban areas. The outputs are being designed to be combined with land use, land tenure and value to support the

national System for Environmental Economic Accounting and Sustainable Development Goal reporting.

During the February to May program increment significant progress was made to be able to provide a draft version of the LCCS to stakeholders for review and feedback. Following this review final changes will be made for delivery of version 1 of LCCS toward the end of 2020.

3.1.4 Burn Extents

Project	Working with	Scale
Landsat Annual Burn Extents	Australian National University, Tasmanian Government	Medium

This project will produce annual burnt extent maps using Landsat imagery and an automated change detection algorithm developed by ANU. The product can be used to understand fire history, especially for forested environments in southern Australia where no consistent large scale burn mapping is available.

3.1.5 Wetland Insight Toolkit

Project	Working with	Scale
Wetlands Insight Toolkit (WIT)	DAWE, CEWO, MDBA, QLD DES, QLD Herbarium, VIC DELWP	Medium

This project is developing a wetland asset monitoring web service. This product will allow DAWE, CEWO and the MDBA to monitor changes in the wetness and vegetation health of identified wetlands across Australia. Initially this project is targeting wetlands listed under the Ramsar Convention on Wetlands.

3.1.6 Fractional Cover of Water

Project	Working with	Scale
Fractional Cover of Water (FWC)	Australian Rivers Institute/CEWO	Medium

This project will establish methods to better identify the percentage of water in areas of mixed water and vegetation, such as wetlands, mangrove forests and floodplains. This will enable the more accurate determination of inundation extent during environmental flow events and flood events. This will also enable a more accurate description of wetland hydrological regimes. DEA has contracted the Australian Rivers Institute (Griffith University) to collect UAV footage to identify water extent. This work is being undertaken to support the decision making needs of the CEWO, MDBA and QLD/NSW State Governments. The fieldwork required to collect data for this project has been delayed by COVID 19 travel restrictions.

3.1.7 Wetland analysis to support the Murray Darling Basin Plan evaluation

Project	Working with	Scale
Wetland analysis to support the MDB Plan evaluation	CEWO	Medium

The CEWO and Geoscience Australia are working together to describe the temporal and spatial characteristics of wetland inundation associated with environmental water delivery in the Murray-Darling Basin (MDB). This project will include:

- Determining the spatial extent of inundation for each site for each event from 2014-2018 at each Ramsar site across the Murray Darling Basin
 - Determining the additional impact of environmental watering events;
- Identifying the area of each specified vegetation type for each Ramsar site inundated for each event for a range of specified time intervals.
- Verifying the remotely sensed extent with available ground-truthed data (e.g. OEH dataset in NSW)
- Identifying potential changes in vegetation condition across each Ramsar site using an appropriate metric. Where possible, verifying this remotely sensed data with on-ground observations.

The scope is limited to Ramsar wetlands in the MDB that can be influenced by environmental water.

3.1.8 Inland Water Quality Monitoring

Project	Working with	Scale
Inland Water Quality	CSIRO, State governments, MDBA MARIS (Industry)	Medium

This project aims to establish an operational inland water quality monitoring capability on DEA, underpinned by an extensive field work campaign to acquire parameterisation and validation data. The project will enable near-real time and historical analysis of water quality components such as chlorophyll-A and suspended sediments, to assist state and commonwealth monitoring and reporting programs. Incorporation of citizen science and other in-situ measurements will enable development of further applications such as improved identification of harmful algal blooms, and reporting against SDG indicators.

3.1.9 DEA component of Great Artesian Basin project

Project	Working with	Scale
Great Artesian Basin (GAB) project	MEG Division	Small

This project aims to characterise the volume of water contained within the Great Artesian Basin (GAB), and identify/characterise the behaviour of groundwater dependent ecosystems linked to the GAB. The project will consist of providing MEG with advice on how to analyse WOfS, Tasselled Cap Wetness and WITs to achieve these aims.

3.1.10 Near Real-Time Bushfire Fuel Moisture

Project	Working with	Scale
Near Real-time Fuel Moisture	Australian National University and BNH-CRC	Small

This project seeks to provide users with an improved understanding and awareness of bushfire fuel moisture through the development of a national, near-real-time bushfire fuel moisture product.

This project will develop a near-real-time fuel moisture product using Sentinel-2 data in collaboration with ANU, as an implementation of a BNH-CRC project.

3.1.11 Intertidal extent in the Northern Territory

Project	Working with	Scale
NT Intertidal extent	Northern Territory Government, National Indigenous Australians Agency, Australian Hydrographic Office	Large

The NT Government via the National Indigenous Australians Agency has requested support from Digital Earth Australia to map the extent of the intertidal zone in the Northern Territory to support Native Title Claims. The NIDEM and DEA Mangroves products are both being considered as inputs into the methods for defining the extent of the intertidal zone. Members of the DEA will be working closely with NT Government to identify the suitability of the existing DEA products in meeting these requirements and developing more detailed products if required.

3.2 On the Horizon

Project	Objectives
National Wetlands Inventory	DEA will leverage the Landsat archive to create a national inventory of wetlands.
Fractional cover for Department of Agriculture	This project is developing a composited monthly fractional cover product using Sentinel-2 and Landsat data and the Joint Remote Sensing Research Program (JRSRP) fractional cover algorithm.
Change Detection and Monitoring	Change Detection and Monitoring
Mangrove Uptake by NCAS	Embed the National Mangrove Canopy Extent Map and related workflows in NCAS processes.
National Soil Condition	DEA will work with CER, DAWE and other stakeholders to provide input to a national soil condition map.
National Vegetation Condition	DEA will work with CER, DA, DAWE and other stakeholders to develop a national vegetation map.
Northern Basin Hydrometrics and Remote Sensing	DEA will work with the MDBA, NSW DPIE and QLD state government to deliver products and services in support of its Improving water information in the Northern Basin program.
Survey of mining activities using remote sensing data	This project is developing automated algorithms to monitor mine development and mine rehabilitation activities in regional and Northern Australia.



4 Marine and Coastal

Through the establishment of an ocean and coastal monitoring capability, Digital Earth Australia (DEA) aims to provide a suite of products and tools that can be used to tackle a broad range of marine applications spanning mapping and monitoring environmental conditions, offshore resources and fisheries sectors. However, as DEA's experience lies predominantly in the terrestrial domain, it will be essential that the program work with experts from across the marine and coastal domains to identify where it can provide value.

There are a wide range of government stakeholders working on specific applications in the water quality area; including the Integrated Marine Observing System (IMOS), Australian Institute of Marine Science (AIMS), CSIRO and the Bureau of Meteorology (BoM). DEA will seek to leverage the expertise of these and other groups to support development of new capabilities in marine and coastal monitoring, and build consensus around best practise methods to implement, identifying key users and stakeholders, and determining a longer term strategy for meeting their requirements.

By leveraging the time series data and analytical capability DEA provides, we will provide government with a combination of historical baselines, operational and monitoring products, and high quality scientific analysis tools. The ability to target these capabilities at a continental scale and high spatial resolution of 10-25 m uniquely positions DEA to tackle a range of problems not currently addressed in government programs, and provide solutions which complement existing scientific and monitoring efforts.

Specific issues that can be addressed by a DEA marine capability include mapping sea-surface properties across the marine estate to monitor ocean temperature and identify marine heat-waves, trace patterns in sediment discharge from land to sea in sensitive coastal areas, and map changes in the extent and health of coastal mangrove forests and seagrass meadows as a measure of blue carbon storage. As the DEA data holdings continually improve, so will the complexity of the algorithms it can support, enabling more complex ocean variables such as chlorophyll to be derived, to further understand the health and productivity of our oceans.

One of the challenges in working in this environment is the requirement of calibration, validation and in-situ data; held and acquired by a wide range of commonwealth, state and academic institutions. In collaboration with CSIRO, the DEA program is collating comprehensive databases of these available field data in the marine environment. This will enable the development and application of algorithms to produce high resolution monitoring and mapping capabilities for a range of ocean and coastal variables.

The ability of the DEA to produce both historical and near real-time products means that current events or seasonal effects can be interpreted in relation to robust historical baselines, enabling informed management decisions to be made.

A key area of application will be reliable mapping of changes in the position and stability of coastal landforms, such as river mouths (harbours), intertidal areas and urban beaches. Documenting change in the geomorphology of these areas provides necessary context for understanding responses to climate change impacts, notably coastal erosion as forced by sea-level rise and intense storms. To

ensure consistency of this analysis, DEA coastline change products will be linked to the national coastal sediment compartments framework, providing functional boundaries to the coast within which practical management strategies can be applied.

4.1 Current Projects

4.1.1 Shallow Water Habitat Mapping

Project	Working with	Scale
Shallow Water Habitat mapping	State Governments, SatDek	Small

This project is exploring the use of satellite imagery to detect seafloor habitats, bathymetry and water column properties in marine waters that are shallower than about 20 m depth. The project will initially focus on identifying seafloor habitats but will also consider bathymetry and geomorphology.

Near-real time and historical analysis will support managers of marine estate with their monitoring and reporting programs. Preliminary capability testing and development has focussed on detecting seagrass environments around Australia. We are presently exploring a potential collaboration with the University of Queensland to implement an approach they have developed for mapping geomorphological and benthic reef environments onto the DEA platform.

4.1.2 Characterising Sea Surface Temperature dynamics of Australia's Marine Parks

Project	Working with	Scale
Sea Surface Temperatures (SST)	DAWE	Small

This project is developing Sea Surface Temperature (SST) data visualisation capabilities to enable Marine Parks within DAWE to inform their Monitoring and Evaluation Reporting framework.

4.1.3 Coastal Change Characterisation

Project	Working with	Scale
Coastal Change	NEMO (GA)	Small

This project aims to support coastal decision-makers by identifying national hotspots of coastal change and Australia's most vulnerable shoreline geomorphologies. Sub-pixel analysis techniques are applied to the Landsat archive to develop: (1) annual, national coastline contours, and (2) a national point-dataset that presents statistical relationships between rates of coastal change and key environmental drivers. These DEA products will be used to test and augment existing national coastal management products (e.g. Coastal Compartments and Smartline).

4.2 On the Horizon

Project	Objectives
Ocean Colour & SST Statistical Summary	Develop a range of flexible tools to enable time series and statistical analysis of the full range of ocean EO products. These tools will underpin products that provide insights into marine heatwaves, cold water upwelling events, chlorophyll dynamics, and ocean current dynamics
National Mangrove Mapping V.3	This project will improve upon the methodology used to produce the National Mangrove Map version one product and address issues with the underestimation of national mangrove extents



5 Analysis Ready Data

Analysis Ready Data (ARD) is Earth observation data that has been processed to a minimum set of requirements and organised into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and space, and with other datasets. ARD is a fundamental starting point for further analysis, and ARD collections such as Surface Reflectance Landsat data form the basis for the majority of the information products currently produced by DEA.

The DEA program will steadily increase the breadth and depth of its analysis-ready collections with the addition of data from a range of satellites sensors and, in time, other sources of Earth observations such as rainfall and stream gauge data, radiometric and climate surface information.

Over the next two - four years, the DEA program anticipates creating and extending ARD collections from the following satellites: Landsat-5, Landsat-7; Landsat-8; Sentinel-1A / 1B; Sentinel-2A / 2B; ASTER, Sentinel-3A / 3B; Himawari-8; Terra and Aqua.

5.1 Current Projects

5.1.1 Analysis Ready Data - Production Code Upgrade

Project	Working with	Scale
ARD Code Upgrade	MDBA and DAWE	Medium

This project will focus on the development of code to enable routine delivery of definitive, Sentinel-2 and Landsat surface reflectance products. The definitive products make use of the latest, up-to-date ancillary information regarding atmospheric constituents such as aerosols and water vapour.

Planned algorithm/software (wagl) upgrade:

1. MODTRAN 6 integration: improved efficiency (3 to 1); updated solar irradiance file for SR improvement in blue and ultra-blue bands, replace flux table method to avoid errors for water absorption bands, e.g., Sentinel-2 band 9.
2. New angle implementation: this improvement will avoid mosaic boundary issue due to different aerosol data used in adjacent Sentinel-2 tiles and for the streamlined implementation of the algorithm for new sensors.
3. Terrain mask: to avoid noise in flat area in terrain illumination corrected Surface Reflectance products (NBART).
4. BRDF: Collection 6 BRDF implementation and surface structure based BRDF (instead of scene based). It will improve the SR for data captured both in summer and winter.
5. Improved ancillary inputs, such as ECMWF and similar data available from BoM.
6. An ARD code base is currently being developed for the routine production of Normalised Radar Backscatter (NBR) as well as interferometry and coherence.

The NBR product is of immediate interest to the community looking to map surface water, as well as land surface objects in general. The coherence product is highly suitable to community doing any surface mapping such as land cover.

The production of interferometry data is a direct requirement for the National Subsidence Mapping project. Without the routine production of interferometry data, the National Subsidence Mapping project will stall.

5.1.2 Surface Reflectance Validation

Project	Working with	Scale
Reflectance Validation	CSIRO, TERN, AusCover	Medium

This project aims to establish a nationally agreed field validation strategy for the DEA surface reflectance product. It is intended that the strategy will also serve as the basis for community-led collaborative validation of other optical EO products.

In collaboration with CSIRO and state and territory actors, the DEA Reflectance Validation project will develop good practice field measurement protocols, identified appropriate validation sites across Australia and collected field data for use in validation of the DEA surface reflectance products. Phase one of the project concluded recently with data collection completed for over a dozen sites across Australia.

Phase two will extend these efforts through the use of Remotely Piloted Aircraft System (RPAS), commonly called drones. This RPAS capability will be tested early in 2020 and a measurement model developed to extend the ARD teams' validation capability. The RPAS will allow collection of spectral data over complex sites with vegetation, terrain and water. Validation of surface reflectance and other products is critical for ensuring their quality, and for users to determine the products' fitness for purpose.

5.1.3 Aquatic Surface Reflectance

Project	Working with	Scale
Aquatic Surface Reflectance	CSIRO	Medium

This project will develop a surface reflectance product for marine and coastal environments. Similar to the original terrestrial surface reflectance processing, adjustments will be made to the standard processing workflow to account for specific variables such as aerosols encountered in the marine environment.

Alternative ancillary data sources have been assessed, and CSIRO has validated the end product and processing workflow.

An implementation of the algorithm has been developed and is publicly available from wagl, specifically the water-atcor branch. Various locations across Australia have been identified and samples from 2013-2018 for Landsat 8 have been generated.

The next phase of the project will entail gathering user feedback to:

- finalise the product specifications;

- identify explicit logical behaviour that determines an acquisition to be processed by the Aquatic Surface Reflectance algorithm; and
- logically determine the aerosol model to use when processing an acquisition.

5.1.4 National Subsidence Mapping

Project	Working with	Scale
Surface Deformation	Geodesy (GA)	Small

This project aims to up-scale InSAR processing to enable the generation of subsidence map products for the whole Australian continent using Sentinel-1 SAR data. This subsidence product will contribute to better constrained national geodetic products (e.g. 4D national surface deformation models) and other GA work programs. It is also envisaged that the subsidence products could have a significant impact on the work of Federal and State government department stakeholders, by informing regulatory and policy practices, particularly in the resources sector.

The current priorities are (i) defining a national framing for Sentinel-1 SAR and InSAR data products; (ii) finalising the InSAR ARD product formats and specifications and (iii) generating InSAR ARD products for the States of NSW and Victoria.

5.1.5 Assessment of the ESA Sentinel-2 Surface Reflectance Product

Project	Working with	Scale
Assessment of the ESA Sentinel-2 Surface Reflectance Product	ESA, Copernicus Data Hub	Medium

This joint project with members drawn from the Copernicus Australasia Data Hub and ESA will evaluate the fitness for purpose of the ESA Sentinel-2 surface reflectance product for use in Australia/ New Zealand. A workshop to discuss partner contributions to the Project and progress towards the evaluation will be held in May 2020, outcomes from the workshop will help focus future effort on the assessment of ESA's Sentinel-2 surface reflectance product.

5.2 On the Horizon

Project	Objectives
Himawari-8 ARD	High revisit (10 minute) observation cycle for use in dryness and hotspot monitoring.
Sentinel-3 ARD	Provision of data continuity for MODIS program and ocean monitoring applications.
Assess Quality of USGS LST product	Review USGS land surface temperature products for accuracy and quality.
Surface Reflectance Near-Real-Time Service	Deliver Landsat-7 ETM+ and Landsat-8 OLI Surface Reflectance products in near-real-time for up-to-date compliance monitoring and change detection by users.
Update the Sentinel-2 Surface Reflectance Collection	The Sentinel-2 Surface Reflectance Collection requires reprocessing to be consistent with the newly processed Landsat Collection 3, as well as to incorporate the changes that ESA have published such as an updated Spectral Response function.

Project	Objectives
Multi-sensor ARD Inter-comparison and Sensitivity Analysis	Provide answers for two fundamental questions: 1. How well do Surface Reflectance products from multiple sources or sensors compare through time (consistency) and with respect to in-situ measurements (absolute accuracy)?; and 2. Which parameters must ARD algorithms/approaches have in common to minimise artefacts for inter-sensor operability?
Sentinel 2 Cloud Masking	Cloud masking algorithm for the project has been developed and implemented. The next phase is to set up ongoing processing at a frequency of once per month for a given Sentinel 2 MGRS tile.



6 Platform Improvement

Addressing the storage, processing and analytical challenges posed by the increasingly significant volumes of Earth observation data from satellites and other sources is a key driving factor behind the technical development of the DEA technical platform.

Improvements to the performance and capability of the platform through regular code releases and the development of new analytical techniques will be driven in part by the requirements of the projects and project partners outlined in this roadmap, but also by the need to ensure the platform remains up-to-date with technical advances in Earth observations, data management and analysis, and high performance and cloud computing.

6.1 Current Projects

6.1.1 Open Data Cube 2.0

Project	Working with	Scale
Open Data Cube 2.0	ODC Community	Large

Now that a number of organisations are making operational use of the ODC, the patterns of its use are better understood. By having access to use cases, DEA has been able to identify opportunities to simplify the project.

In order to implement these simplifications, it's necessary to make breaking changes in the code. This project seeks to create a new major version of the ODC - Version 2.0. Consequently downstream software will need to adapt. More importantly, Version 2.0 provides an opportunity to modernise and simplify the project in a range of areas. The work will be undertaken as a collaborative effort between ODC stakeholders including GA and, as a result of the ODC Hackathon in February 2020, has the support of the ODC community.

6.1.2 Data Pipelines Uplift

Project	Working with	Scale
Data Pipelines Uplift	ODC community	Medium

This project will continue to improve the processes used to generate new analysis ready data (ARD) products and derivatives as upstream data becomes available. As each data product has different requirements and we have two separate ways to generate data products following the production of the ARD:

1. As ARD scenes become available, run downstream algorithms on each scene (e.g. Fractional Cover or WOfS)
2. Regularly generate a data product based on all the ARD available in the last period (e.g. Annual Geomedian)

This project will improve monitoring, reduce latency and deliver data at a reduced cost while also increasing confidence in routine product generation.

6.1.3 SpatioTemporal Asset Catalogue

Project	Working with	Scale
Spatio Temporal Asset Catalogue (STAC)	International EO community	Medium

SpatioTemporal Asset Catalogue (STAC) is an emerging metadata standard that is being developed in conjunction with international collaborators including:

- providers of free EO data;
- commercial satellite operators and EO data on-sellers;
- private sector space consultancies;
- Academia.

DEA is engaged with the STAC project to ensure that DEA products are made available with the most accessible metadata. This will mean tools developed for interacting with DEA data are interoperable with that of other EO data providers and vice versa.

6.1.4 DEA Sandbox and Science Algorithm Portability

Project	Working with	Scale
Algorithm Sharing	ODC community	Medium

The same satellite data which DEA relies upon for its products is also used around the world by many organisations to create their own products and monitoring systems. Several organisations are starting to use the underlying Open Data Cube code for their data management. But at the moment there is significant work required to transform the algorithms which operate on the data.

By ensuring that as many example algorithms as practicable are able to be run on the DEA Sandbox, we gain confidence that these algorithms are portable. There are potential time savings and collaboration opportunities that arise from being able to readily share our science algorithms with other parties. Inversely, DEA also benefits from being able to run algorithms developed elsewhere on our own data.

The DEA Sandbox continues to improve with more reliable infrastructure and better notebooks that work on it. ANU has been contracted to provide training on the sandbox to government users at both state and federal level.

6.1.5 NCI Platform Upgrades

Project	Working with	Scale
NCI Platform Upgrades	ODC community	Small

The NCI is undergoing a process to change over to a new supercomputer Gadi. To ensure a smooth transition we'll need to rebuild the DEA packages to work with the new platform, and customise some of data pipelines to cope with changes to the platform.

After this changeover the new platform should increase the performance of some of our algorithms and make developing new algorithms easier.

DEA is working closely with the NCI to ensure our services work after the transition is complete, with minimal impact to end-users.

6.1.6 Datacube Statistician

Project	Working with	Scale
Datacube Statistician	DEA	Small

The Datacube Statistician project's goal is to re-envision the Datacube Statistics tool so that it will work in a cloud environment. In simple terms, Datacube Statistician will take a simple configuration that can be translated into a computation graph, and will apply it over a defined grid of areas as a batched process.

The tool will complement Datacube Alchemist, which is a dataset-to-dataset engine, and will comprise reusable components developed in Datacube Core, Datacube Tools and EO Datasets as well as a core project to tie it all together

6.2 On the Horizon

Project	Objectives



7 Data Visualisation and Delivery

Data visualisation (the presentation of data in a pictorial or graphical format) is particularly important when dealing with the complexity and scale of Earth observation data. Data visualisation enables decision makers to see analytics presented visually, simplifying difficult concepts and identifying patterns in the data that might otherwise be overlooked. Interactive visualisation takes the concept further by using technology to drill down into and manipulate the data to enable customisation of scenarios and the analytical outputs for particular purposes.

The DEA program will develop (and support development of) a range of data visualisation tools and services that will enable users to manipulate, analyse, interpret and present Earth observation data and information products in ways that are meaningful and relevant to the users' needs. DEA aims to use industry-standard protocols and formats wherever possible.

A suite of standards-based technologies are used to share this spatial data, typically set out by an organisation such as Open Geospatial Consortium (OGC). A Web Map Service (WMS) can be used to display spatial data with a style or colour ramp, to be viewed on websites or in Geographic Information System (GIS) software. A Web Coverage Service (WCS) is used to transfer the underlying data between applications, such as a server to a client GIS package or analysis tool. A Web Processing Service (WPS) is used to run an analysis tool remotely, and return the results to the user. The combination of these can bring the required information to a user, without having to download entire datasets.

7.1 Current Projects

7.1.1 Digital Earth Australia Hotspots Upgrade

Project	Working with	Scale
Digital Earth Australia Hotspots	DiSI, Landgate WA	

DEA Hotspots (previously known as Sentinel Hotspots) uses satellite data to detect potential bushfires, map their impact and model their spread, and makes this information available to relevant Commonwealth, State and Territory Governments, as well as the general public. DEA is collaborating with Landgate to develop a national hotspot system to remove duplicate systems, ingest new hotspots sources, increase cost efficiencies and implement research outputs developed by the Bushfire and Natural Hazards Corporative Research Centre.

7.1.2 DEA Sandbox

Project	Working with	Scale
DEA Sandbox	FrontierSI, CSIRO	Medium

DEA is collaborating with FrontierSI and CSIRO on the development and hosting of an integrated analytical platform to demonstrate the use of Open Data Cube with Digital Earth Australia's cloud hosted decision ready data. The goal of this platform is to attract and inspire small and big businesses to tap into known and emerging applications of remote sensing data to stimulate economic growth within Australia. In an effort to ensure our systems are safe and resilient to attack we always perform security enhancements alongside all our other feature enhancements.

7.1.3 Open Data Cube Web Processing Service Development

Project	Working with	Scale
ODC WPS	Data61	Small

DEA developing services that enable on the fly time series analysis of its EO archive and derived products through the WPS standard to platforms such as National Map. Exposing this functionality through intuitive workflows and reusable, standard interfaces will mean that these services can be consumed and enjoyed by a greater audience.

7.1.4 NCI Web Services Development

Project	Working with	Scale
NCI Web Services Development	NCI and users	Small

This project supports the development of NCI's Geospatial Data Server, GSKY, which provides a key component of DEA's data delivery infrastructure. The objective of the project is to provide enhanced data services which support improved data delivery services.

The current priority is to make Landsat Collection upgrade data available through this platform. The NCI have implemented and circulated a Beta web service end point of DEA's LandSat collection upgrade for review. DEA has worked with NCI to implement a Normalised Burn Ratio (NBR) web service in response to the most recent Australian fire season. The next phase of the project is to work with end users to test the usability of both the LandSat collection upgrade service and the NBR.

7.2 On the Horizon

Project	Objectives



8 Data Management

At its core, DEA is a series of structures and tools that calibrate and standardise datasets, enabling within-sensor time series analysis and the rapid development of quantitative information products. DEA addresses the formerly costly and time-consuming process of downloading, analysing and providing satellite imagery and other geospatial datasets to users.

By calibrating the entire data stream to the same standard in advance and by making the data accessible in a High Performance Data (HPD) structure co-located with a High Performance Computing (HPC) facility, the data can be viewed as enabling infrastructure for data-intensive science.

Over the next ten years, the volume of EOS data available to Australian programmes is set to grow substantially, having already taken our storage requirements from the terabyte to the petabyte scale. The acquisition, storage and management, search and discovery of these rapidly increasing data collections is a critical facet of the DEA program. DEA will continue to develop and improve tools for the management of its data and metadata, the automation of processing for ancillary data, and improved search and discovery of its collections.

Alongside improvements to data management tools, DEA will work to increase the efficiency of its ARD and derivative product processing pipelines to ensure the continuity of supply of high quality data out of the Australian continent. Of primary importance to the current suite of DEA products are the currency, integrity and quality of its Landsat archive.

Historically, Landsat data has been downlinked or downloaded from the USGS Landsat satellites and online archives, processed to surface reflectance for Australian conditions, then used to develop a range of derived information products such as Water Observations from Space, Fractional Cover, and High and Low Tide Composites.

During 2018, DEA will undertake a systematic review of the potential impact of transitioning from an Australian managed data architecture to one in which Landsat Level 1 processing is handled by the USGS. This is a fundamental change that may have lasting impacts on the downstream products produced by DEA and other Australian users of the Australian Landsat Archive managed by Geoscience Australia.

The reasons for undertaking this review, and potentially switching to a USGS managed pipeline, are variously:

- USGS-managed Landsat archives are several generations ahead of the Australian archives in terms of processing software and correction algorithms applied to the base satellite data.
- Maintaining (potentially unnecessary) separate processing pipelines is inefficient when USGS-processed data may be suitable for the vast majority of Australian applications.
- Many Australian (and the majority of international) users are already basing their downstream products and decision-making on the USGS-processed Landsat data, making it a default standard.

DEA will work with Australian end users of Landsat to understand and assess the potential impact of this change through the Collection Upgrade and Transition Analysis and other related projects.

8.1 Current Projects

8.1.1 Landsat Collection Upgrade

Project	Working with	Scale
Landsat Collection Upgrade	NASA, USGS	Medium

The Collection Upgrade project will establish a new baseline for Landsat products within DEA.

Following an initial assessment of the impact of transitioning from Australian-managed data architecture, to one in which Landsat Level 1 processing is handled by the USGS. The overall objective of the project is to ensure that DEA maintains the most efficient processing chain possible for Landsat data.

DEA will establish a new Landsat data collection by downloading Level 1 data directly from the USGS, and providing additional data in areas of particular significance to DEA via supplemental processing with DEA in-house systems. Production parameters for these supplemental datasets will be modified slightly from the USGS specification to enable more “stackable” data.

Following an initial assessment of the impacts of the new level 1 baseline, the forward program of work will adapt derivative product generation procedures to make use of the new baseline input. The collection upgrade will provide significant advantages to DEA users in terms of maintaining consistency with USGS products and provision of the latest improvements in Level 1 processing by the satellite data providers. The upgrade represents a major advance in GA and USGS cooperation on the Landsat mission. Through influencing the production processes on the US side, GA is reducing the need for unnecessary duplication of effort.

The project will also work to introduce a new naming convention for DEA products with a view to rolling this out across other mission data as new products are developed.

8.1.2 Technical content update

Project	Working with	Scale
DEA webpage content update	NEMO (GA)	Small

This project will review and update the technical content relating to DEA products to improve discovery and consistency of product documentation across our range of products and services.

8.1.3 Asia-Oceania Data Hub Demonstrator

Project	Working with	Scale
Asia-Oceania Data Hub Demonstrator	Asia Oceania GEO (AOGEO) community.	Medium

This project aims to develop a shared data hub for Analysis Ready Data in a commercial cloud over the Asia Oceania Region. The AOGEO Data Hub demonstrator is collecting data over the three pilot areas being Samoa, the Mekong River delta and the Kanchenjunga Landscape in the Himalayas. The hub contains in situ data and satellite data from the space agencies of China, South Korea and Japan. This project is now scoping whether the AOGEO Data Hub concept can be merged with the UN-GGIM-AP Asia Pacific Networked Geospatial Data Platform project.

8.1.4 Automated Reporting

Project	Working with	Scale
Automated Reporting	NEMO, DiSI	Medium

This project will provide DEA with improved reporting and management of data storage and compute resources across our infrastructure through collation of statistics and automated reporting. A public view of this will allow users to monitor data currency and completeness as it progresses through the DEA value chain.

8.1.5 Operationalising Production

Project	Working with	Scale
Operationalising Production	NEMO, DE Africa	Medium

Through a consistent approach to automation of routine production processes, DEA will improve data management and reduce product latency. This project will review and document current automation practice with a view to adopting a simplified workflow management approach. Specialists from across the program will form a working group to establish a code of practice for automation. This has multiple benefits; from reducing redundancy, to simplification of code management, task execution and monitoring, and consistent logging inputs to automated reporting.

8.1.6 DEA Access

Project	Working with	Scale
DEA Access	NEMO (GA)	Small

The DEA Access project will provide a web-based search and download capability to users. The system is based on a widely adopted framework utilised within a number of European earth observation data hubs. It incorporates a metadata catalogue and search engine API dedicated to geospatial data (resto), a semantic enhancement web service (itag) to facilitate tagging of products with additional information to facilitate data discovery, a gazetteer, and map-based web application or user interface (rocket).

8.2 On the Horizon

Project	Objectives

9 User Engagement

Almost every sector in the Australian economy benefits from the use of spatial information and location technologies and the potential to develop satellite applications and services tailored for the regional and global markets is huge, with recent studies suggesting the geospatial services sector generates US\$400 billion in revenue per year globally⁶. A recent Australian Government report⁷ demonstrates that Earth and marine observing is currently worth \$29 billion to Australia and \$543 billion to APEC economies each year. The value to Australia is forecast to increase to \$96 billion by 2030.

Enabling the Australian spatial industry to exploit the full value of EOS information to enhance their business and be competitive in global markets is a key goal of DEA. The products created by Australian businesses and researchers using DEA will be transferrable to international markets as they evolve. The underpinning satellite data is global, and the United Kingdom, United States, Canada, and South Africa, Colombia and Vietnam are exploring their own deployments, based on DEA.

Understanding the requirements of Australian businesses for Earth observations, data infrastructure, and information products is integral to the success of DEA and to fully realising the benefits of spatial information.

In addition to direct industry partnership projects, DEA continues to work with community coordination groups such as Earth Observation Australia and the Earth Observation for Government Network to better understand broader Australian requirements for Earth observation products and services. DEA continues to work with these groups to coordinate the implementation of the *National Earth Observation for Space Infrastructure Plan*, the *Australian Earth Observation Community Plan 2026* and *2026 Spatial Industry Transformation and Growth Agenda*.

9.1 Current Projects

In 2018/19 DEA undertook a nationwide consultation process which led to the development of the DEA Industry Strategy. A key pillar of the strategy was the implementation of a pilot incubator program - DEA Labs. Announced in April 2019, DEA Labs provides successful business applicants with up to \$50,000 and technical support to prototype, test, refine and operationalise systems or products that incorporate DEA data and/or technology. DEA Labs is also helping DEA better understand the needs of Australian businesses and tailor its approach to industry engagement.

The 2019 pilot round of DEA Labs received over 30 applications from multiple sectors – triple the number anticipated. Eight projects were shortlisted, three of which were successfully funded. The three pilot projects (CiboLabs, DataFarming, and NGIS Australia) were successfully completed in early 2020 with all three companies producing commercially viable products that they will be able to use in their businesses and sell to their users.

- CiboLabs used DEA-provided Sentinel-2 data and cloud computing to dramatically reduce the overhead in processing pasture biomass products for its clients.

⁶ AlphaBeta, The economic impact of geospatial services: how consumers businesses and society benefit from location-based information, 2017. https://www.alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report_Sept-2017.pdf

⁷ Australian Government, Current and future economic value of earth and marine observing to the Asia Pacific region, November 2019. <https://www.industry.gov.au/data-and-publications/current-and-future-value-of-earth-and-marine-observing-to-the-asia-pacific-region>

- DataFarming developed an innovative method to automatically extract paddock boundaries from Landsat data.
- NGIS Australia developed successful processes for analysing both Landsat and Sentinel-2 data and will provide users of its Decipher product with improved crop information and insights.

A second round of DEA Labs projects is currently planned for the 2020-21 financial year.

9.1.1 Market Research Study

Project	Working with	Scale
Market Research Study	FrontierSI	Medium

This 18-month project aims to address awareness and education gaps in an initial set of five major Australian industry sectors (Agriculture, Mining/Extractive Industry, Financial Services/Insurance, Urban Planning, and Infrastructure Development), and establish mechanisms through which Geoscience Australia can appropriately and actively engage those sectors to maximise the uptake of both satellite data and DEA products and services.

The project will deliver detailed market research in these sectors that will:

- explore which market segments within each sector are most ready to adopt satellite data and DEA tools
- identify key organisations that can act as advocates and partners to allow DEA to reach into each sector
- identify critical challenges to the increased adoption of satellite data in each sector
- assess potential use of technology and education in increasing uptake and awareness within sectors.

DEA and FrontierSI completed consultation with the Agriculture sector in January 2020 and is currently engaging directly with the Mining and Extractive Technologies sector through a series of interactive online workshops.

9.1.2 DEA training for Government

Project	Working with	Scale
DEA training for Government	ANU	Medium

In this project ANU has developed a training program tailored for government staff that draws on existing DEA documentation and new content to develop a suite of training materials available via Open Access Repository for use by DEA users. Four pilot training workshops were being delivered by ANU between August 2019 and March 2020 involving over 90 participants from federal and state government and associated universities.

The success of this program has resulted in plans to further develop the course into a full online offering available both nationally and internationally.

9.1.3 Earth Observation for Government Network

Project	Working with	Scale
(EOGN) Engagement	University of QLD	Small

GA has partnered with University of QLD to establish and run the EOGN. DEA Product Development and Operation leads are members of the Network who provide advice and input to the Network. The EOGN will maximise the benefits to Government of EO data by facilitating a shared understanding of needs and use of EO Data and its derived products at all levels of Government. Furthermore, EOGN will work to increase the use of EO products by removing barriers and help facilitate the transition of EO research to continental wide operational products. EOGN has run prioritisation workshops in August 2019, and will run targeted workshops for the high priority themes covering land cover/land use followed by vegetation/biomass and water products in 2020. It has also established an EO capability database that will be revised annually.

9.1.4 Bushfire Earth Observations Taskforce

Project	Working with	Scale
Bushfire EO Taskforce	ASA, BoM, CSIRO AGO	Small

In January 2020 Minister Karen Andrews called together a Bushfire Earth Observation Taskforce to build coordination of the Federal Government response to bushfires and other natural disasters. The Taskforce is led by the Australian Space Agency, with support from Geoscience Australia, the Bureau of Meteorology, CSIRO and Australian Geospatial intelligence Organisation. The aim is to coordinate a Federal Government response to the 2020 fires and build capability so as to be better prepared for the next fire season. In response, DEA is accelerating the development of its bushfire extent and severity mapping projects, further improving the DEA Hotspots service, and engaging with international partners to develop new sources of hotspot data and burn scar information from Sentinel-3.

9.1.5 DEA Labs Round Two

Project	Working with	Scale
DEA Labs	FrontierSI, Positioning Australia, Australian industry partners	Small

DEA Labs is a small scale innovation grants program that provides support for Australian businesses to use satellite data and DEA technologies to develop new commercial products, and increase their productivity and profitability.

- DEA is currently working to scope the Round Two projects including:
- incorporating lessons learned from the Round One projects
- determining the grant approach; challenge or call for submissions
- finalising the governance and project management models.

DEA expects to announce a second round of funded projects early in the 2020-21 financial year.

9.1.6 Website Prototype Research and Design

Project	Working with	Scale
DEA Online R&D	Today, various stakeholders	Small

DEA is working with Today, a full-service design and technology company to understand how we can better engage a wide range of stakeholders and audiences through digital channels.

The aim of the project will be an improved DEA website and digital experience, which will be the home of products and tools to enable innovation and support decision making.

The project will include a technical discovery to ensure that DEA understands the needs of all stakeholders, their expectations, their challenges, and identify opportunities for different users and different uses. Following this Today will design and test digital prototypes to help audiences easily navigate the complexity of DEA to achieve their end goal.

On the Horizon

Project	Objectives

10 International Engagement

DEA's International Engagement Strategy has three goals:

1. Ongoing data security
2. Improving the data provided by satellite operators
3. Opening global markets for Australia's EO industry

GA works internationally to ensure Australia has access to the Earth observation data it needs, including for Digital Earth Australia but also more generally for national priorities. This includes specifically satellite data and influencing future missions and data policies, but also non-satellite data critical to exploitation of satellite datasets for national priorities.

As Australia has no sovereign Earth observation satellite capability, good relationships with international satellite operators and coordinating groups are critical to ensure the ongoing supply of Earth observation data to Australia. DEA will manage Geoscience Australia's engagement with these agencies and groups and work with the Australian spatial sector to increase the use of Earth observations to drive economic growth and create export opportunities for Australia's Earth observation app developers.

Geoscience Australia's geospatial expertise combined with its understanding of how to exploit satellite data means it is a valued partner of Australian Space Agency in supporting Australia's involvement in national and international civil space activities. GA is working with ASA to identify opportunities for Australian industry to contribute to the global satellite Earth observation system, including areas where Australian missions may help address Australia's own needs while supporting Australia's commitments to the global Earth observation community.

Geoscience Australia also engages internationally to ensure the supply of satellite Earth observation data to Australia is streamlined. This involves influencing the supply of data from upstream to be reliable and immediately 'fit for use' within the Australian ecosystem thereby reducing the need for users, particularly GA, to build and maintain their own bespoke data pre-processing pipelines.

As noted above, DEA is supporting the spatial services sector to produce new products that they can in turn sell to farmers, mining companies, etc. This work has positioned Australia as a global leader in the exploitation of satellite data and has the potential to provide Australian companies with an invaluable 'first-mover' advantage in growing global markets. Geoscience Australia also engages internationally to identify opportunities, create partnerships, and lower barriers to Australian companies exporting their Earth observation products and services globally, with an initial focus on the Asia-Pacific region where the value of Earth and marine observing (EMO) to economies is expected to reach \$1.35 trillion by 2030.

10.1 Current Projects

10.1.1 Support for industry engagement including through the Group on Earth Observations

Project	Working with	Scale
GEO Support	GEO, AOGE0, Earth Observation Australia and Australian EO industry	Small

Consistent with the call from the *Canberra Declaration for GEO* (November 2019) to consider how the GEO Work Programme can support the private sector, this project is working through the GEO Executive Committee and Programme Board to ensure GEO's future approach encourages and facilitates the growth of the private sector. The forthcoming 2020 GEO Symposium in June is a key milestone in support of this. The virtual-only format will make some activities more challenging, but also creates opportunities for greater participation by SMME's and other players not usually able to make a face-to-face meeting in Geneva. The project will, over the next twelve months, develop a business case for coordinated Australian Government support for Australian EO businesses to export their products and services.

10.1.2 Governance support for the Committee on Earth Observation Satellites

Project	Working with	Scale
CEOS Support - governance	CEOS, CSIRO	Small

This project will provide support for the 2020-2021 CSIRO/GA CEOS SIT Chair Period. CSIRO and GA's priorities emphasise Analysis Ready Data (which lowers technical barriers for Australian users), Carbon and Greenhouse Gas Monitoring, and the use of satellite Earth observations for the Sustainable Development Goals. The SIT-35 meeting, which was successfully held in March, has laid the foundation for the upcoming SIT Technical Workshop to be held virtually over two weeks in early September. .

10.1.3 Strategic support for the Committee on Earth Observation Satellites

Project	Working with	Scale
CEOS Support - strategic	CEOS	Small

This project will drive the implementation of the CEOS Analysis Ready Data (ARD) Strategy, as a key part of our strategy to streamline Australia's supply of satellite EO data, and reduce the risk of technical and policy risks arising from being entirely dependent on individual international partners.

10.1.4 Establishment of the Australian Government EO Coordination Office

Project	Working with	Scale
Australian Government EO Coordination Office	CSIRO	Small

This project will identify and secure support for a joint CSIRO-GA funded Australian Government EO Coordination Office, which also supports a “Team Australia” approach to contributions to forums such as CEOS and GEO as well as improved national coordination including support for Earth Observation Australia. A major responsibility of the office will be to coordinate cross-Australian Government efforts to open up markets for Australian Earth observation companies to export their products and services.

10.1.5 Key bilateral partnerships

Project	Working with	Scale
10.1.5 GA-USGS Collaborative EO Program	USGS, EC/ECA	Medium

This project will continue to build relationships with both EC/ECA and USGS, leveraging cal/val activities to provide concrete evidence that influences their respective forward data processing plans. The focus will be on collaboration with USGS under the GA-USGS Collaborative EO Program in the context of the future ‘Landsat Collection 3’, and with the EC/ESA on their future plans to provide Analysis Ready Data.

10.1.6 LandsatNext

Project	Working with	Scale
LandsatNext	NASA, USGS, ASA	Medium

This project will work to ensure that NASA/USGS are aware of possible contributions that Australia could make to the Sustainable Land Imaging program beyond Landsat-9. Geoscience Australia will work jointly with the Australian Space Agency to promote opportunities to develop and leverage Australian space industry capabilities. A concrete Australian contribution to the space segment of the Landsat program will help secure future data supply.

10.1.7 Digital Earth Africa

Project	Working with	Scale
Digital Earth Africa	GEO, GA, AfriGEOSS, WEF, UNECA, ARDC, SANSa, IWMI, AWS, OSS, CSE; AGRHYMET, GEOGLAM, RCMRD, Dlab, AFRIGIST, COOI Studios, GPSDD	Large

Digital Earth Africa will improve understanding of Africa's changing landscape, providing much-needed insights, knowledge and analysis for more informed, strategic and inclusive decision-making across the continent.

10.1.8 Open Data Cube Community Development

Project	Working with	Scale
ODC Community	ODC Community	Medium

This project will continue to build relationships with technical users of the Open Data Cube and related technology in order to grow the community around the project. The ODC is going through the process of becoming an OSGeo Project, which will set it in place amongst peers in the open source geospatial community and will provide guidance in ways of working. The ODC Conference will be supported and Hackathons and other initiatives that help to build capability and strengthen relationships are being organised.

10.2 On the Horizon

Project	Objectives
APEC follow up	In support of the follow-up its APEC EMO report, which identified major opportunities for EO Products and Services in the APEC region, we will explore technical collaboration that could help open up markets and build capacity in the region to take up Australia's EO products and services. This may include "sub regional" work across the Asia Pacific with Latin America, South East Asia and the Pacific.
Australia-Mexico work to connect geospatial and statistical datasets	This collaboration will explore how open datacube geospatial can better support socioeconomic and demographic (statistical) data activities. The project will draw on the experiences, capabilities and data from Australian Bureau of Statistics, the Mexican Institute of Geography and Statistics, INEGI and GA to develop one or more prototype products in the areas of Agriculture and Urban development.

Appendix A Products

A.1 Product Summary

Product	Description	National Map	Product Link
Tasselled Cap Wetness Statistics	Percentiles of wetness indices provide insight into the temporal dynamics of wetlands, salt lakes and groundwater dependent ecosystems.		http://pid.geoscience.gov.au/dataset/ga/135494
DEA Waterbodies	Identifies Australia's natural and man-made waterbodies, with associated time series of the change in surface area within each satellite observation.	✓	http://pid.geoscience.gov.au/dataset/ga/132814
Water Observations from Space	A summary of surface water observations derived from Landsat imagery for all of Australia from 1987 to the present.	✓	http://pid.geoscience.gov.au/dataset/ga/121054
Daily, Seasonal, and Annual Water Summaries	A summary of water classified scene information (clear count, wet count, frequency) from the Water Observation Feature Layers over a particular period of time (all-time, annual, seasonal...).	✓	http://pid.geoscience.gov.au/dataset/ga/121074
National Yearly Average Image	High-dimensional, continental-scale pixel composite mosaics for landscape characterisation (Geomedian).	✓	http://pid.geoscience.gov.au/dataset/ga/120374
National Barest Earth Image	A national composite image representing the barest (i.e., least vegetation) state for each Landsat pixel across Australia.	✓	http://pid.geoscience.gov.au/dataset/ga/122573
National Fractional Cover	A 25m x 25m footprint of the proportions of living vegetation, dry/dying vegetation and bare soils across Australia.	✓	http://pid.geoscience.gov.au/dataset/ga/102285
National Fractional Cover Percentiles	Statistical (10th, 50th and 90th percentile) summaries of fractional cover per epoch (whole-of-archive-summary, annual, seasonal) from 1987 to the most recent full calendar year.	✓	http://pid.geoscience.gov.au/dataset/ga/120843
National Mangrove Canopy Cover	A series of national maps of mangrove canopy cover and extent from 1987 to the most recent full calendar year.	✓	https://nationalmap.gov.au/#share=s-6F7eMKFcPEGAYOGTCaFT1XF7UM8
Intertidal Extents Model	A national dataset of the exposed intertidal zone; including the relative height and depth of the intertidal zone of Australia's coastline.	✓	http://pid.geoscience.gov.au/dataset/ga/113842
National Intertidal Digital Elevation Model	A continental-scale elevation dataset for Australia's exposed intertidal zone.	✓	http://pid.geoscience.gov.au/dataset/ga/123678

High and Low Tide Images	The High and Low Tide Composites (HLTC) are mosaics produced to allow visualisation of the Australian coastline and reefs at high and low tide.	✓	http://pid.geoscience.gov.au/dataset/ga/113843
Landsat Surface Reflectance	Landsat-based collections of Earth observation data that has been corrected for variations caused by atmospheric properties, sun position and sensor view angle and terrain.	✓	http://pid.geoscience.gov.au/dataset/ga/102288
Sentinel-2 Surface Reflectance	Sentinel-2-based collection of Earth observation data that has been corrected for variations caused by atmospheric properties, sun position and sensor view angle.	✓	http://pid.geoscience.gov.au/dataset/ga/101785
Dynamic Land Cover Dataset	Nationally consistent and thematically comprehensive land cover reference for Australia.	✓	http://pid.geoscience.gov.au/dataset/ga/71071

Product	Description	Prototype	Product Link (Terria link)
Wetland Insight Tool	Provides users with a quick and easy view of the change in water, vegetation and soil within a wetland over the last 30 years.	✓	http://terria-cube.terria.io/#share=s-qVxFiKXzvKEUc7w01Pf70gr1qFp
Landscape Insight Tool	Provides users with a quick and easy view of the change in water, vegetation and soil within a single paddock over the last 30 years for the areas affected by major flooding in the Flinders River floodplain in early 2019.	✓	https://terria-cube.terria.io/#share=s-qSXU2f8RkExrduNOiiV527bMAGW

Appendix B Document Control

B.1 Changelog

Revision Date	Change Location	Change Description
May 2020	Section 3, Land Cover and Land Use	Tasselled Cap Wetness Statistics, project completed and product published. Environmental watering in the MDB since 2014 renamed Evaluation of Environmental watering in the MDB since 2014 Fractional Cover for the Department of Agriculture, moved to Horizon Survey of mining activities using remote sensing data, moved to Horizon Change Detection and Monitoring, moved to Horizon National Wetlands Inventory, moved to Horizon Floodplain Mapping, project completed Near Real-time burnt extent mapping project discontinued Near Real-time fuel moisture. New project
	Section 4, Marine and Coastal	National Mangrove Mapping V.3 moved to Horizon
	Section 6, Platform Improvement	Scalability and Performance, project completed. Datacube Statistician. New project.
	Section 8, Data Management	DEA Access moved from Horizon to Current. Automated Production renamed Operationalising Production
	Section 9, User Engagement	DEA Labs (round one) projects completed. DEA Labs Round Two, moved from Horizon to Current. Website Prototype Research and Design. New project
	Section 10, International Engagement	Sentinel 1 ARD Pipeline for Digital Earth Africa, project completed. ABS/INEGI Spatial Data collaboration. New project.
March 2019	Section 1, Land Cover and Land Use	DEA Waterbodies. Project completed. Moved to products Tasselled Cap Wetness Statistics completed. Not yet published. National Wetlands Characterisation project moved from horizon to current and renamed National Wetlands Inventory. Near Real-time burnt extent mapping. Project moved from horizon to current.

Revision Date	Change Location	Change Description
		Intertidal extent in the Northern Territory. New project with NT Govt and National Indigenous Australians Agency, Australian Hydrographic Office
	Section 5, Analysis Ready Data	Sentinel-2 Cloud Masking moved from current to horizon.
	Section 6, Platform Improvement	Architecture Documentation collapsed into Open Data Cube 2.0
	Section 7, Data Visualisation and Delivery	S3 Save removed from Horizon as project is paused.
	Section 8, Data Management	Automated reporting moved from horizon to current. Automated Production new project. DEA Access new project.
	Section 9, User Engagement	Bushfire Earth Observations Taskforce new project with the ASA, BoM etc.
December 2019	Section 3, Land Cover and Land Use	Surface Reflectance Stats for Land cover mapping. Project completed WA Ground Cover removed from Current. Project paused. Tasselled Cap Statistics. Title changed to Tasselled Cap Wetness Statistics. Crop and Dam Mapping. Project completed. Survey of mining activities using remote sensing data. New project with DIIS. Urban Feature Classification. Project completed. Fractional cover of Water. New project. MDBA Water Information in the Northern Basin retitled Improving water information in the Northern Basin. National Land Use Map Integration with DEA removed from Horizon. Reducing Life Lost from Heatwave Project removed from Horizon as it is not a DEA led project. Short-latency Burn Mapping retitled Near Real-time burnt extent mapping.
	Section 4, Marine and Coastal	Bureau of Meteorology Sea Surface Temperature Products, Project completed. Charactering the Sea Surface Temperature of Australia's Marine Parks. New project. National Mangrove Mapping V.2 Project completed. National Mangrove Mapping V.3. New project.
	Section 5, Analysis Ready Data	SAR Analysis Ready Data Development. Project completed. National Surface Deformation retitled National Subsidence Mapping
	Section 6, Platform Improvement	Automation and Orchestration project is now complete, replaced with Data Pipelines project Move geomedian component to new Data Pipelines project, add points about monitoring and network improvements.

Revision Date	Change Location	Change Description
		NCI platform upgrades new project as we transition to the new supercomputer
	Section 7, Data Visualisation and Delivery	NEII Viewer Extension. Project completed. Climate Data deleted from on the Horizon. Project paused. Renamed from Jupyter Hub to DEA Sandbox, include CSIRO as collaborator
	Section 8, Data Management	Asia-Oceania Data Hub Demonstrator moved from Horizon to Current and retitled. Automated Reporting (public facing). New Horizon project
	Section 9, User Engagement (retitled from Industry and Community Engagement)	Market Research Study, Moved from horizon to current DEA training for government. New project. Earth Observation for Government Network. New engagement project.
	Section 10, International	Support for industry engagement by the Group on Earth Observations. New project Governance support for the Committee on Earth Observation Satellites. New project Strategic support for the Committee on Earth Observation Satellites. New project Establishment of the Australian Government EO Coordination Office. New project GA-USGS Collaborative EO Program. New project LandsatNext. New project Sentinel 1 ARD Pipeline for Digital Earth Africa. New project

B.2 Glossary

Term	Definition
ABARES	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACLUMP	Australian Collaborative Land Use and Management Program
ACT	Australian Capital Territory, territory (AUS)
AIMS	Australian Institute of Marine Science
AMA	Analytical Mechanics Associates (US)
ANU	Australian National University
ARDC	Africa Regional Data Cube
AFRI-GEOSS	Africa Global Earth Observation System of Systems
AO-GEOSS	Asia Oceania Global Earth Observation System of Systems
API	Application programming interface. Protocols and tools for building application software.
ARD	Analysis-Ready Data. Data that has been processed with a set of standard corrections.
ASA	Australian Space Agency
AURIN	Australian Urban Research Infrastructure Network
AusCover	TERN multi-agency partnership on national terrestrial remote sensing data (AUS)
AWS	Amazon Web Services. Cloud computing infrastructure provided by Amazon.
BNH-CRC	Bushfire and Natural Hazards Collaborative Research Centre
BoM, Bureau	Bureau of Meteorology (AUS)
BRDF	Bi-directional Reflectance Distribution Function
CEOS	Committee on Earth Observation Satellites
CER	Clean Energy Regulator
CRCSI	Cooperative Research Centre for Spatial Information (AUS)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (AUS)
CSST, NZCSST	Centre for Space Science Technology (NZ)
Data61	CSIRO's data innovation group
DAWE	Department of Agriculture, Water and the Environment
DAWR	Department of Agriculture and Water Resources (AUS) no longer as of 1 Feb 2020
DEA	Digital Earth Australia
DFAT	Department of Foreign Affairs and Trade (AUS)
DGGS	Discrete Global Grid System
DIIS	Department of Industry, Innovation and Science (AUS) no longer as of 1 Feb 2020
DISER	Department of Industry, Science, Energy and Resources
DLCD	Dynamic Land Cover Dataset
DoEE	Department of the Environment and Energy (AUS) no longer as of 1 Feb 2020
DPIPWE	Department of Primary Industries, Parks, Water and Environment (TAS)
DPIRD	Department of Primary Industries and Regional Development (WA)

DWER	Department of Water and Environmental Regulation (WA)
EC	European Commission
EO	Earth observation/s
EOA	Earth Observation Australia. Community coordination group.
EOS	Earth observations from space
ERIN	Environmental Research and Information Network (AUS)
ESA	European Space Agency
ET	Evapotranspiration
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
eWater	Australian Government owned not-for-profit organisation.
FAO	Food and Agriculture Organisation
FarmMap4D	Australian provider of geospatial information to the agricultural sector.
FC	Fractional Cover
GA	Geoscience Australia
GEO	Group on Earth Observations
GHD	GHD Pty Ltd.
GIS	Geographic information system
GSKY	Suite of web services developed by the NCI
HLTC	High and Low Tide Composites (DEA product)
HPC	High performance computing
HPD	High performance data
IDC	Interdepartmental Committee
IMOS	Integrated Marine Observing System
ITEM	Intertidal Extents Model (DEA product)
JRSRP	Joint Remote Sensing Research Program (AUS)
LCCS	Land Cover Classification System
MDBA	Murray-Darling Basin Authority
MODIS	Moderate resolution imaging spectrometer. Sensor on the Aqua and Terra satellites.
MOU	Memorandum of understanding
NASA	National Aeronautics and Space Administration (US)
NBAR	Nadir BRDF Adjusted Reflectance
NBAR/T	Nadir BRDF Adjusted Reflectance (Terrain)
NCI	National Computational Infrastructure. Supercomputer at Australian National University.
NDC	Nationally Determined Contributions. Carbon sequestration and adaption measurement.
NDVI	Normalised Difference Vegetation Index
NEII	National Environmental Information Infrastructure (AUS). Environmental data platform.
NEMO	National Earth and Marine Observation Group (GA)
NLI	National Location Information Branch (GA)
NLUM	National Land Use Management

NRM	Natural Resource Management/Managers
NRT	Near-real time. Generally, rapid processing of satellite data for time critical applications.
NSW	New South Wales, state (AUS)
NSW DOI	Department of Industry (NSW)
NT	Northern Territory, territory (AUS)
ODC	Open Data Cube
OGC	Open Geospatial Consortium
PM&C	Department of the Prime Minister and Cabinet (AUS)
Prapability	Product/capability (cognate)
QLD	Queensland, state (AUS)
SA	South Australia, state (AUS)
SAR	Synthetic aperture radar
SBT	Surface brightness temperature
SDG	(UN) Sustainable Development Goal
SME	Small-to-medium enterprise
SoE	State of Environment. Report and reporting measures overseen by DoEE (AUS).
ST	Surface temperature
SWAMpy	Shallow Water Analytical Methods in Python
TAS	Tasmania, state (AUS)
TBC	To be confirmed
TERN	Terrestrial Ecosystem Research Network (AUS)
UAV	Unmanned aerial vehicle
UK	United Kingdom of Great Britain and Northern Ireland
UK Catapult	UK Satellite Applications Catapult. UK-based technical development company.
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UQ	University of Queensland (AUS)
USGS	United States Geological Survey (US)
UXD	User experience design. User-centric design principles and development.
VIC	Victoria, state (AUS)
VIIRS	Visible Infrared Imaging Radiometer Suite. Sensor on the Suomi NPP satellite.
WA	Western Australia, state (AUS)
WABSI	Western Australian Biodiversity Science Institute
WCS	Web coverage service. Standard web service for retrieval digital geospatial information.
WEF	World Economic Forum
WMS	Web map service. Standard web protocol for serving georeferenced map images.
WOfS	Water Observations from Space (DEA product)
WPS	Web processing service. Standard web service for geospatial processing services.