Australian Government
Geoscience Australia

Digital Earth
AUSTRALIA

Program Roadmap

November 2018

Contents

1 Introduction

1.1 Background

Digital Earth Australia (DEA) is an analysis platform for observations of all forms, but particularly those captured from satellites which have unique potential and pose particular challenges for their full exploitation. DEA uses images and information recorded by satellites orbiting our planet to detect physical changes across Australia in unprecedented detail. DEA prepares these petabytes of satellite data for Australian conditions and makes it available to governments and industry for easy use.

DEA will enable 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/or forest cover in Australia.

DEA will also support 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 will 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 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 will support Australia's broader 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 program will also collaborate 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 will benefit government departments and agencies that need accurate and timely spatial information on the health and productivity of Australia's landscape and will provide Australian industry with access to stable, standardised data from which it can innovate to produce new products and services.

DEA will also create 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 will deliver robust data infrastructure and information products that will:

1. Increase the efficiency and effectiveness of Australian government programs and policies.
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://2026agendacom.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. Through this capability, DEA will support a broader agenda of 'nature forecasting' and make substantial contributions to prediction services such as the planned Environmental Prediction System, as outlined within *Australia's 2016 National Research Infrastructure Roadmap*.

This future goal of establishing a meaningful forecast for land and water provides a framework for the longer-term development 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, will be increasingly be called for; that is models that incorporate a knowledge of process; for example, 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 agenda 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 work plan to be undertaken by the DEA Program in order to achieve its objectives and deliver benefits to the Australian Government and industry. The Program Roadmap is a living document that will be regularly updated.

DEA is a highly collaborative program that is constantly on the lookout for opportunities to collaborate with others to generate value to its stakeholders. The program's approach to development will be to test ideas through innovation and rapid production of new beta products and capabilities. It is expected that not all endeavours will produce viable outcomes, and the program will follow an iterative approach in which it will take small, smart steps, pause and learn, then build that learning 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.

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 Interdepartmental Committee, Project Partners, and other collaborators.

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.

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. The product development cycle is illustrated in the diagram below.

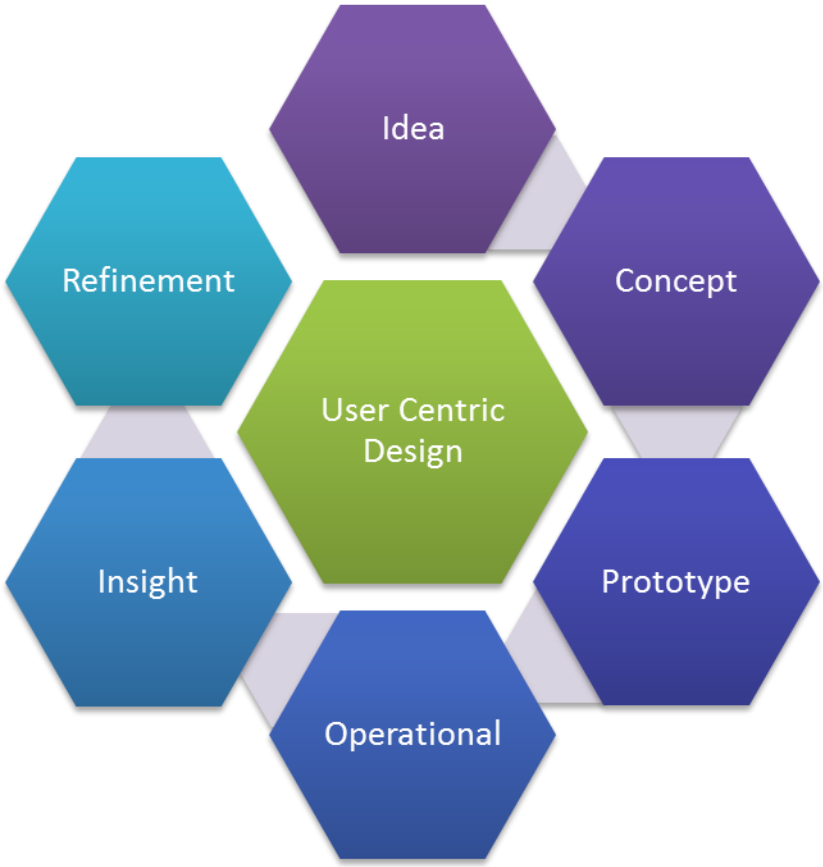

Figure 1 DEA Product Development Cycle

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. Usually the product will be made available to users through platforms such as NationalMap (www.nationalmap.gov.au), 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.

2.5 Project Scale

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).[3] 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.

Large-scale image composites (e.g. national-scale satellite image mosaics) are increasingly important for a variety of applications such as land cover mapping, change detection and the generation of high quality data to support modelling applications. DEA provides a series of structures and tools that calibrate and standardise datasets, enabling the application of time series and the rapid development of quantitative information products for use in change detection applications.

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 three inputs to the ABS National Land Accounts (with land value 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.

[3] http://www.agriculture.gov.au/abares/aclump/land-use

To develop a comprehensive land cover suite, DEA will work through Australian Government partners such as the Department of the Environment and Energy and Earth observation community groups such as the 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 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 Fractional Cover Percentiles

Project	Working with	Scale
Fractional Cover	JRSRP	Medium

Fractional Cover (FC) provides a 25 m x 25 m ground footprint of the proportions of living vegetation, dry/dying vegetation (including deciduous trees during autumn, dry grass, etc.), and bare soils across the whole Australian continent.

Fractional Cover Percentiles are statistical products that characterise fractional cover dynamics across a year or a season. These products can be used to understand wind/water erosion risk and can also be used as input into land cover classification algorithms to identify crops, woody vegetation, persistently bare areas and similar land cover classes.

3.1.2 Crop and Dam Mapping

Project	Working with	Scale
Crop and Dam Mapping	MDBA, NSW DOI	Medium

This project will use the Water Observations from Space product to identify persistent water in the landscape. Polygons identifying the locations of dams and on-farm storages will be produced, and an accompanying time series of fill and draw down events for every identified water body will be pre-computed. It is planned that these results will be provided to project partners via a web service.

This project will also produce a product identifying irrigated crop extent, updated annually.

3.1.3 NDVI Percentiles

Project	Working with	Scale
Crop Extents	MDBA, NSW DPI	Medium

Water availability is a critical factor that drives agricultural decision-making and financial outcomes for primary producers. Using satellite data the DEA can develop information on spatial and temporal trends in water use which is critical for adaptive decision-making about how to manage scarce water supplies. Understanding irrigator responses to changes in water availability and irrigator responses to seasonal changes is also critical for building strategies to support effective management of water resources.

Following the successful completion of an irrigated crop mapping trial, DEA will develop a national scale NDVI percentiles product and evaluate its suitability for irrigated crop extent mapping.

3.1.4 LCCS National Product

Project	Working with	Scale
National LCCS	University of Aberystwyth	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.

3.1.5 Tasselled Cap Statistics

Project	Working with	Scale
Tasselled Cap Statistics	Groundwater Branch	Small

The tasselled cap statistics project will deliver percentiles of the brightness, greenness and wetness indices. These percentiles provide insight into the temporal dynamics of wetlands, salt lakes and groundwater dependent ecosystems.

3.1.6 Barest Earth

Project	Working with	Scale
Barest Earth	Mineral Prospectivity (GA)	Small

This project will make the Barest Earth product developed by Geoscience Australia's Mineral Prospectivity group with support from DEA available to users via the National Map platform.

3.1.7 Urban Feature Classification

Project	Working with	Scale
Urban Features		Medium

This project will investigate the use of DEA and EOS to identify urban areas and detect changes due to construction or other phenomena. The first phase of the project will involve developing an operational workflow based on machine learning approaches to urban feature classification.

3.1.8 New Approaches to Statistical Analyses of Time Series Data

Project	Working with	Scale
Time Series Statistics		Small

This project continues from the Geomedian work, providing Data Cube users with robust statistical tools such as change hypothesis testing and machine learning classifiers. These tools have application in the monitoring of landscape features such as water, vegetation, cropping and urban change.

The next products are change detection datasets such as the Median Absolute Deviation, based on annual, continental pixel composite mosaics. These products provide annual datasets of variance in the landscape, highlighting change.

3.1.9 Burn Extents

Project	Working with	Scale
Burn Extents	Australian National University	Medium

The DEA Burn Extents project is developing automated algorithms to map burnt area extent, and incorporating existing burn scar algorithms from other agencies. This will provide a set of burn scar mapping tools at the Sentinel-2 and Landsat scale, plus investigate incorporating MODIS-based burn scar mapping into DEA. In addition a new set of fire severity tools are being investigated to help understand the impact of fires in the Australian environment.

3.2 On the Horizon

Project	Objectives	Status
Water SDG Monitoring	Establishing a method for reporting on water quality against the relevant SDGs.	Medium
Forest Cover	Collaborative development of a new national forest cover product.	Planning
Water Observations from Space, Sentinel-2	Addition of other sensors to improve resolution. Expand the range of WOfS statistical summary products.	Planning
National Wetlands Extents Map	Improved identification and characterisation of wetlands.	Planning
National Land Use Map Integration with DEA	Greatly improved efficiency, frequency and precision in NLUM reporting.	Pre-planning
Sentinel-2 Fractional Cover	Production of 10m resolution FC from Sentinel-2, consistent with Landsat-based FC.	Planning
Land Degradation Monitoring	Test CSIRO approach to monitoring land degradation for SDG 15.	Planning
Wetlands Characterisation	Improved identification and characterisation of the response of wetlands to environmental flows.	Planning

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 National Mangrove Mapping

Project	Working with	Scale
National Mangrove Map	DSITI QLD, University of Aberystwyth	Medium

This project will update and improve Australia's continental-scale mangrove extent and change map developed by DEA, the Terrestrial Ecosystem Research Network and the Joint Remote Sensing Research Program. The Great Barrier Reef Marine Park Authority is making use of the DEA mangrove product as input to the 2019 GBR Outlook report. The product will be used to characterise the extent and dynamics of mangroves in the GBR reporting region over the last 5 years, with a particular focus on how tropical cyclones have impacted mangroves during that period.

4.1.2 Shallow Water Habitat Mapping

Project	Working with	Scale
SWAMpy	CSIRO	Small

This project will develop a capability to derive a three-category (green, white, brown) classification of the seafloor to inform natural baselines for marine habitats such as seagrass against which changes can be measured over time. The intended use case is the mapping and monitoring of benthic habitats, such as seagrass, by Parks Australia.

Seagrass (for the most part) exists in shallower waters (above 20m) although there is record of some beds as deep as 40m. The ability to map sea grass habitats (even to a 3 category level; green, white, brown) would be a useful tool to:

- provide support for targeted investment for further surveys/mapping activities
- provide the opportunity to investigate whether the 3 categories could be expanded to allow for sea grass to be more specifically characterised from other "green" sensed areas
- inform discussions where there are adjacent reserves with sea grass beds spanning both state and federal management areas
- enable Parks Australia to have a future reporting capability into the national carbon accounts.

4.1.3 National Intertidal Extents Digital Elevation Model

Project	Working with	Scale
NIDEM	James Cook University	Small

The National Intertidal Extents Digital Elevation Model project aims to improve mapping of coastal intertidal and subtidal (marine and estuarine) ecosystems through the delivery of a national scale intertidal digital elevation model (NIDEM) derived from the Intertidal Extents Model (ITEM) product.

4.1.4 Coastal Change Characterisation

Project	Working with	Scale
Costal Change	NEMO (GA)	Small

The development of tidally tagged composites that are used to generate NIDEM identified areas where the coastline has changed at some point over the last 30 years. This project will place those areas of change into the context of the coastal compartments and 'smartline' coastal geomorphological classifications. This project will identify coastline types where EO techniques can be used to understand coastal stability and coastal erosion risk, and demonstrate how EO techniques can provide insight into rates of coastal erosion for some coastline types.

4.1.5 Ocean Colour Statistical Summary

Project	Working with	Scale
OC Stats	NEMO (GA)	Small

This project will improve GA's ability to characterise Australia's 'blue water' marine reserves. This will be achieved through the development of a statistical summary ocean colour product based on MODIS Ocean Colour products. These statistical summaries will provide insight into the time series and trends in chlorophyll concentration.

4.1.6 Sea-Surface Temperature Statistical Summary

Project	Working with	Scale
SST Stats	NEMO (GA)	Small

This project will improve GA's ability to characterise Australia's 'blue water' marine reserves. This will be achieved through the development of a statistical summary sea surface temperature product based on MODIS SST products. These statistical summaries will provide insight into the marine heatwaves, cold water upwelling events and ocean current dynamics.

4.2 On the Horizon

Project	Objectives	Status

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 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-7; Landsat-8; Sentinel-1A / 1B; Sentinel-2A / 2B; 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 DoEE	Medium

The Surface Reflectance Definitive project represents the formative piece of work being undertaken by DEA to deliver surface reflectance products based on Landsat and Sentinel-2 data.

The 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. Emissivity product to correct Surface Brightness Temperature to LST – Land Surface Temperature (LST) is the standard product defined in CEOS ARD specification.

5.1.2 Landsat Surface Reflectance Near-Real-Time Service

Project	Working with	Scale
Landsat SR NRT		Medium

The delivery of Landsat-7 ETM+ and Landsat-8 OLI Surface Reflectance products in near-real-time (NRT) has been identified as a requirement by users including the Murray Darling Basin Authority, FrontierSI and Cibo Labs.

These organisations require NRT data streams for up-to-date compliance monitoring and change detection.

The Landsat NRT products are produced using historic ancillary data. The Landsat NRT service will be established within the current quarter.

This work will leverage developments in the Analysis Ready Data – Code Upgrade project to deliver state of the art Surface Reflectance Products via web services with minimal turnaround from acquisition to product delivery via nationalmaps.gov.au.

5.1.3 Landsat ARD Inter-comparison and Sensitivity Analysis

Project	Working with	Scale
ARD Sensitivity	USGS	Medium

This project will provide an evidence base to support strategic decision making by answering two fundamental questions:

1. How well do GA and USGS Surface Reflectance products compare relatively 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 in inter-sensor operability.

5.1.4 Answers to these questions are critical inputs to the Landsat Collection Upgrade

Project	Working with	Scale
Landsat Collection Upgrade	NASA, USGS	Medium

and will inform decisions about potential changes to the way in which Landsat data is processed by DEA for Australia.

5.1.5 Surface Brightness Temperature Validation

Project	Working with	Scale
SBT		Small

This project will validate the prototype Surface Brightness Temperature (SBT) product based on Landsat data. Historical field based thermal measurements over four different sites in Australia will be used to validate the prototype SBT product for the corresponding period.

The validation of the prototype SBT product will pave the way for future development of Land Surface Temperature and Evapotranspiration products. The latter product in particular is a valuable input for improving our understanding of evapotranspiration rates for land and water management, groundwater ecosystems and aquifer recharge.

The availability of global Land Surface Temperature products from the USGS and their utility for Australian applications will have a bearing on future development of similar products within DEA. The current validation of the prototype SBT product would inform future decisions about generating Land Surface Temperature products that are fit for use in Australia.

5.1.6 Surface Reflectance Validation

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

The DEA Reflectance Validation 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, not just those of DEA.

In collaboration with CSIRO and state and territory actors, the DEA Reflectance Validation project will develop good practice field measurement protocols, identify appropriate validation sites across Australia and collect field data for use in validation of the DEA surface reflectance products. Validation of surface reflectance and other products is critical for ensuring their quality, and for users to determine the products' fitness for purpose.

5.1.7 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 encountered in the marine environment.

As part of this project, alternative ancillary data sources will be assessed and CSIRO will validate the end product and processing workflow.

The aquatic surface reflectance product will be a valuable input to future marine applications such as shallow water habitat mapping and turbidity.

5.1.8 National Surface Deformation

Project	Working with	Scale
Surface Deformation	Geodesy (GA)	Small

Interferometric Synthetic Aperture Radar (InSAR) is technique that is used to produce maps of surface motion from temporal stacks of Synthetic Aperture Radar (SAR) data. Through a series of case studies, the Geodesy Section has demonstrated a range of InSAR based applications including monitoring subsurface resource extraction, subsurface tunnelling, mapping of earthquake deformation, volcano monitoring (in Papua New Guinea) and detection of nuclear tests (in North Korea).

This project will scale-up this capability in order to generate InSAR products over large areas of Australia will contribute to better constrained national geodetic products (e.g. 4D national surface deformation models).

The DEA and the InSAR Team in Geodesy will work together to achieve large-scale processing of Sentinel-1 SAR data, with the aim of generating a product(s) over a portion of Australia that can demonstrate the benefits of the InSAR capability to a range of stakeholders prior to scaling up the product to achieve national coverage.

The proposed InSAR Project is complementary to an existing DEA-CSIRO effort to evaluate a suite of Analysis Ready Data (ARD) products for SAR. It is envisaged that output products and candidate ARD definitions developed in the InSAR Project will contribute to the DEA-CSIRO project outcomes as well.

5.1.9 Sentinel-2 Cloud Masking

Project	Working with	Scale
S2 Cloud Mask		Small

The project is to develop and/or define cloud masking algorithms suitable for single scene top-of-atmosphere, single scene surface reflectance and time-series surface reflectance Sentinel-2 images in DEA.

5.1.10 MODIS Indexing

Project	Working with	Scale
MODIS Indexing	NASA, CSIRO, NCI	Small

This project will make MODIS products, currently maintained by CSIRO on the NCI and from acquired from NASA, available through the DEA program's rich analytic platform and web service based delivery capability.

This will allow creation of improved products, validation of existing products and give DEA users greater temporal coverage of their regions of interest.

5.1.11 Evapotranspiration

Project	Working with	Scale
ET	BoM, ANU	Small

This project is being undertaken in collaboration with the Bureau of Meteorology and the ANU to support the decision making needs of the NSW State Government (Department of Primary Industry) and the Murray Darling Basin Authority.

This project will develop a demonstrator capability to map evapotranspiration, which, when operational, would improve our understanding of evapotranspiration rates. This will enable the calculation of water balances, identification of land and water management practices, and characterisation of groundwater ecosystems.

5.1.12 SAR Analysis Ready Data Development

Project	Working with	Scale
SAR ARD	CSIRO	Small

This project will:

- develop a SAR-enabled Data Cube, implementing CARD4L specifications
- help refine and promote the ARD specifications advocated by CEOS, through domestic and International Consultation
- demonstrate a small initial set of applications, namely national-scale surface water mapping and regional-scale rangeland dynamics and mapping.

5.2 On the Horizon

Project	Objectives	Status
Himawari-8 ARD	High revisit (10 minute) observation cycle for use in dryness and hotspot monitoring.	Pre-planning
Sentinel-3 ARD	Provision of data continuity for MODIS program and ocean monitoring applications.	Pre-planning
Climate Data	Establishment of a climate data collection from sources such as DoEE and BoM data archives.	Planning
Improved Landsat Cloud Mask	Provide a time series approach to determining the presence of cloud and shadow in imagery, to improve current single-scene cloud masking techniques.	Planning
Assess Quality of USGS LST product		Planning

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 Enhanced API Access

Project	Working with	Scale
API Access		

This project will focus on improving the usability of DEA's analytic platform by:

- optimizing performance of data access, data storage and parallel processing;
- simplifying access to data by reducing the steps required to perform common use cases;
- enhancing code portability to enable more efficient computation in public cloud HPC.

By improving the core DEA API, DEA will be able to:

- deliver more data, more quickly to more people;
- generate products and insights faster;
- continue to attract international interest and collaborators.

6.1.2 Automation and Orchestration

Project	Working with	Scale
Automation	ODC community	Medium

Arguably the most import aspect of DEA is the delivery of data products to end users. This requires a huge amount of software and data to be deployed, tested and run on an ongoing basis.

This project involves the ongoing improvements to the automatic systems that test and deploy software, and then run said software on freshly available data to produce the end data products.

There will always be some level of manual intervention required, for some of the quality checks, but this should decrease over time as more automation is put into place, and our monitoring improves.

This project will complete the automation of DEA's current Landsat data processing pipeline. This will increase the efficiency of processing downloaded and downlinked Landsat data through to surface reflectance and ensuring lower latency of Australia's national Landsat archive.

6.1.3 SpatioTemporal Asset Catalogue

Project	Working with	Scale
STAC		

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;
- 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 Scalability and Performance

Project	Working with	Scale
Scalability	ODC community	Medium

The core Open Data Cube code upon which most of the DEA infrastructure relies upon for data access and management has served us well for most of our operations so far. However, as the quantity and variety of data being managed grows, we need to stay ahead of the curve in ensuring any performance bottlenecks are addressed before they can cause any serious problems.

- Issues likely to be addressed include: The PostgreSQL database currently handles 10's of concurrent users and stores 10's of millions of dataset records. Assess what work is required to grow to meet the demands of hundreds of users and hundreds of millions of datasets.
- There is a prototype web map service, giving interactive visual access to DEA data stored in cloud providers. There is significant room for performance and efficiency improvements of this service, by incorporating third party caching services, investigating more efficient storage formats, or improving the efficiency of the software itself.
- Legacy approaches to data processing which limit the performance and usefulness of newly developed multithreaded algorithms such as the geometric median. This has a particular impact on continental scale analysis, leading to wasted time and increased failure rates.

6.1.5 Architecture Documentation

Project	Working with	Scale
Architecture Documentation	ODC community	Medium

DEA has a wide range of software used in the production and delivery of its data products and services. There is ongoing work required to ensure that all of the technical processes and tools are adequately documented. Having suitable documentation is also necessary for effective collaboration with ODC partners, by making it clear what problems our software is solving, and how it is architected to solve those problems.

6.1.6 Science Algorithm Portability

Project	Working with	Scale
Algorithm Sharing	ODC community	Medium

The same Earth Observation data which DEA relies upon for its products is also used around the world by many other 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 in transforming the algorithms which operate on the data.

There is huge potential savings in being able to readily share our science algorithms with other parties, and inversely, being able to run algorithms developed elsewhere on our own data.

6.2 On the Horizon

Project	Objectives	Status

7 Data Visualisation and Delivery

Data visualisation (the presentation of data in a pictorial or graphical format) is particularly important when dealing 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 Jupyter Hub

Project	Working with	Scale
Jupyter Hub	FrontierSI	

DEA is collaborating with FrontierSI 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.

7.1.2 NEII Viewer Extension

Project	Working with	Scale
NEII Viewer Extension	Bureau of Meteorology	Small

The National Environmental Information Infrastructure (NEII) Viewer Extension project will link the Bureau of Meteorology's stream gauge network data set with the DEA's historical Landsat archive to enable the visualisation of the extents of environmental flooding. The project will also establish the

protocols, workflows and services necessary to link additional data sets in the NEII and DEA date collections.

7.1.3 Data Publication Governance

Project	Working with	Scale
Data Publication	NCI, AWS, Data61	Medium

The data publication work packages will develop the publication protocols, workflows and web services necessary to deliver DEA data and products to users via the NCI and commercial cloud environments. This effort is directly related to (and has some overlap with) the Copernicus Data Hub, and Data Pipeline Architecture projects, and underpins the visualisation and delivery of DEA's current and future analysis ready data, change detection and land cover products.

7.1.4 ODC Web Processing Service Development

Project	Working with	Scale
ODC WPS		

DEA intends to 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.

7.1.5 ODC WCS Development

Project	Working with	Scale
ODC WCS		

DEA intends to improve its existing WCS capability, to allow users to download full spatial and temporal resolution data as well as focusing on delivery methods such as GeoPDF to enable interactions with DEA data to remote or internet limited users.

7.1.6 NCI Web Services Development

Project	Working with	Scale
NCI Web Services Development	NCI	Small

This project will support the development of NCI's Geospatial Data Server, GSKY, which delivers innovative opportunities and data objectives of the Digital Earth Australia (DEA) program. The overall objective of the project is to provide enhanced data services which support the Objectives of the DEA.

The project will: deliver WMS services via GSKY for specified DEA datasets; develop and maintain the GSKY production service; provide and manage the GSKY code for Open Source access, and; develop additional GSKY functionality to satisfy DEA use cases (as agreed).

7.1.7 Data Dashboard

Project	Working with	Scale
Data Dashboard		

Extensions and improvements to DEA's data dashboard will allow users to:

- traverse the collection of DEA's data archive;
- trace the lineage of derived or summary products;
- alternate means of downloading and acquiring DEA data.

These improvements will also enable DEA data custodians to better address gaps, duplications or errors in DEA's data archive, resulting in higher quality products being delivered more quickly to our end users.

7.2 On the Horizon

Project	Objectives	Status
S3 Save	This project will enable users of DEA's Jupyter Hub to save, export and share insights and data they have created.	Planning

8 Data Management

At its core, DEA is a series of structures and tools that calibrate and standardise datasets, enabling the application of time series 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 processing pipelines to ensure the enduring availability of high quality Australian data archives. 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 uses 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.

8.1.2 Copernicus Australia Regional Data Hub

Project	Working with	Scale
Regional Data Hub	GA, QLD, NSW, WA, CSIRO, NZ CSST,	Small

This project will maintain an operational Australasian storage and synchronisation service for data from the Copernicus satellites (Sentinels). This data will be both lower level processed data (Level 1) and European Space Agency global Sentinel-2 Surface Reflectance (Level 2).

8.2 On the Horizon

Project	Objectives	Status
Asia-Oceania Data Hub	This project will establish and maintain an operational Asia-Oceania regional storage and synchronisation service for satellite data in the Asia-Oceania Region.	Planning

9 Government Engagement

The 2017/18 Budget identified over $2 billion of investments in monitoring, protecting or enhancing Australia's land, coasts and oceans over the next four years including the National Landcare Program, establishment of the expanded Australian Marine Parks, implementation of the Murray-Darling Basin Plan and water reform agenda, support for State and Territory governments to develop secure and affordable water infrastructure, improving water quality, reducing sediment and nitrogen run off, removing crown of thorns starfish and improving scientific knowledge of the Great Barrier Reef. The ability to effectively target this funding and monitor the impact of the expenditure is a key focus of the DEA Program.

DEA has established an Interdepartmental Committee (IDC) with senior representatives from eight Commonwealth agencies to assist in identifying and prioritising the application of the DEA to address challenges of national significance.

In addition, DEA will establish a program of engagement with government departments and other stakeholders to gather requirements for data, infrastructure and services that will inform future DEA projects and deliver benefits to project Partners. At the same time, DEA will work with these Partners to identify operational baselines from which benefits can be quantified.

Projects in this section are explicitly about engagement and requirements gathering exercises with Australian government partners. These projects may lead to the development of products and capabilities that will, in time, feature in other sections of the Roadmap, but they are distinct in their intent from those development activities.

9.1 Current Projects

9.1.1 Murray Darling Basin Authority

Project	Working with	Scale
MDBA	MDBA	Medium

This project will second a DEA Officer to the MDBA. for 10 months to gain better understanding of MDBA functions and procedures and to help upskill MDBA staff in the use of python and DEA.

9.1.2 Seasonal Conditions Update for NSW DPI Agriculture

Project	Working with	Scale
NSW DPI Ag	NSW DPI Ag	Medium

This project is developed to support the NSW Department of Primary Industry to provide a snap shot of the current standing water in the landscape and place this snapshot into a historical context. This analysis of the farm hydrological situation in NSW for the October-Nov period provides the ability to

count the number of dams that are full/mid/low water levels, and report on drought conditions on a parish level.

9.2 On the Horizon

Project	Objectives	Status
Tasmanian Transition	Transition DPIPWE EO products to DEA infrastructure.	Planning
Marine Product Extension	Increase the number of NEMO marine products being produced using the DEA.	Planning
FC and S2 FC for DAWR for GEOGLAM-RAPP	Operational DEA FC feeds for GEOGAM-RAPP.	Pre-planning
ABS Using DEA	Collaborate with ABS to enable their cross tabulation techniques in the DEA environment and train ABS staff to work in the DEA environment directly.	Planning
WA Salinity Mapping/WA Enablement	Enable the mapping of WA salinity on a regular basis	Pre-planning
DEA Products in DoEE Wylie	Scope the requirements for DoEE's Wylie system to utilise DEA web services	Pre-planning
Mangrove Uptake by NCAS	Embed the National Mangrove Canopy Extent Map and related workflows in NCAS processes.	Pre-planning
Prototype Products for Drought Response	Define and develop prototype products for use in Australian government drought response efforts.	Planning

10 Industry and Community Engagement

Almost every sector in the Australian economy benefits from the use of spatial information and location technologies. Spatial information from Earth observations from space (EOS) contributes around $5.3 billion annually through various industry programs, and is projected to generate over 15,000 jobs by 2025.

Globally, the forecasted growth of 30% per annum in geoservices provides a great opportunity for Australian companies to increase their businesses on an international scale. This market has already created around 4 million jobs worldwide, and has the potential to increase productivity in sectors representing around 75 per cent of the global economy.

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. The DEA program is working with the Cooperative Research Centre for Spatial Information to develop an Industry Strategy that ensures the DEA will generate value for the spatial industry and the wider Australian economy.

In 2018/19 DEA will undertake a consultation process with Industry including some early pilot projects. On completion of its Industry Strategy DEA will update this roadmap with a plan on how best to provide Australian Industry with access to Earth observation data, high performance computing and basic analytical tools to enable them to innovate and pilot new applications for later commercialisation.

In addition, DEA will 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 will also 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*.

10.1 Current Projects

10.1.1 Industry Strategy

Project	Working with	Scale
Industry and Economic Value Strategy	FrontierSI	Small

FrontierSI is working with Geoscience Australia and appropriate individuals and industry representatives to develop an Industry Strategy that ensures the DEA will generate value for the spatial industry and the wider Australian economy. The strategy will outline:

- How the DEA will engage with industry.
- Industry requirements of the DEA.
- How the DEA will address industry's requirements.
- What the anticipated benefits of the application of the DEA will be for industry.
- A framework for the identification, prioritisation, selection and management of industry/DEA incubators.

During the quarter, DEA will focus on further engagement with industry through a series of webinars and workshops to gather requirements and establish interest in industry incubator projects.

10.1.2 Natural Resource Management Australia Requirements Analysis

Project	Working with	Scale
NRM Analysis	NRM Regions Australia	Small

DEA will provide support for, and participate in, a series of workshops run by NRM Regions Australia to increase awareness of Geoscience Australia's capabilities and the role that DEA and Earth observations might play in natural resource monitoring and management efforts.

10.2 On the Horizon

Project	Objectives	Status

11 International Engagement

As Australia has no sovereign 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 Australia's engagement with these groups, and work with the Australian spatial sector to increase the uptake and relevance of Earth observations.

Geoscience Australia's geospatial expertise combined with its understanding of how to exploit satellite data means it is a valued partner of the Department of Industry, Innovation and Science (DIIS) in supporting Australia's involvement in national and international civil space activities.

GA's role in supporting Australia's space sector, with a particular emphasis on activities related to Earth observation from space (EOS) data, is explicitly recognised in both the:

- *Australian Government's Satellite Utilisation Policy* which identifies Geoscience Australia, the Bureau of Meteorology and CSIRO as *"… the Australian Government Agencies jointly responsible for Australia's Earth Observations from Space activities";* and
- *Australia's State of Space Report for 2016* which explicitly identifies GA as one of the key agencies responsible for *"… secur[ing] the future pipeline of key EOS data for Australia."*

GA is an active member of the DIIS-chaired *Australian Government Space Coordination Committee* and are co-chairs of associated *Australian Government Earth Observation from Space Working Group*.

GA has played a highly successful role in ensuring that Australia has a secure and stable supply of satellite data and has successfully negotiated agreements with the United States Geological Survey, the European Space Agency and the European Organisation for the Exploitation of Meteorological Satellites to ensure Australia has timely access to key public good satellite data.

More generally, Geoscience Australia is Australia's principal representative to the intergovernmental Group on Earth Observation and an associate member of the international Committee on Earth Observation Satellites (CEOS).

In the near term, DEA will focus on supporting the joint USGS / GA work plan, growing the relationships with the EC and ESA through the Copernicus Data Hub, and supporting Australia's involvement in the Committee on Earth Observing Satellites (CEOS) and the Group on Earth Observations (GEO).

In addition, DEA will continue to contribute code, documentation, How-to guides, tutorials, and support to international users of the Open Data Cube. The Open Data Cube (ODC) initiative seeks to increase the value and impact of global Earth observation (EO) satellite data by providing an open and freely accessible architecture, and fostering a community to develop, sustain, and grow the technology and the breadth and depth of its applications for the benefit of all.

11.1 Current Projects

11.1.1 Support for the Group on Earth Observations

Project	Working with	Scale
GEO Support	GEO, AO-GEOSS	Small

This project will influence the work of GEO through the GEO Program Board and aims to ensure that the GEO Work Program includes activities and deliverables of interest to Australia and the Australasian region.

The project will also support the development and evolution of the Asia-Oceania Global Earth Observation System of Systems (AO-GEOSS).

11.1.2 Support for the Committee on Earth Observation Satellites

Project	Working with	Scale
CEOS Support	CEOS	Small

This project will contribute to CEOS leadership through the delivery of SIT Vice-Chair responsibilities and will encourage the evolution of the CEOS Data Cube Initiative as a platform for GEO projects.

11.1.3 Support for Regional Development Projects

Project	Working with	Scale
Regional Support		Small

This project will identify and secure support from key agencies for projects that can exploit Earth observations for in-country and regional use. The project will work to secure DFAT funding for relevant projects and establish links between Australian industry (in partnership with European, UK and US industry) to export EO applications to the region.

11.1.4 Cambodia Open Data Cube

Project	Working with	Scale
Cambodia ODC	eWater	Small

This project will implement an instance of an ODC for Cambodia on local infrastructure or via the commercial cloud to enable the monitoring of water resource for the Mekong River in Cambodia. It will enable the combination of climate, elevation and Earth observation data with the Source hydrological model to improve understanding of drought and flood cycles for agricultural planning.

This project is the first stage in developing this capability for larger international projects such as the African ODC deployment.

11.1.5 Open Data Cube Community Development

Project	Working with	Scale
ODC	ODC Community	Medium

This project will establish a community around the ODC technology stack that enables people to better exploit earth observation data globally.

11.1.6 Digital Earth Africa

Project	Working with	Scale
DA Africa	GEO, GA, AfriGEOSS, WEF	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.

Digital Earth Africa is driven through a collaborative partnership that includes GEO, Geoscience Australia, AfriGEOSS, and the World Economic Forum.

11.2 On the Horizon

Project	Objectives	Status
Mekong ODC	Develop an ODC for the Mekong river basin	Pre-planning

Appendix A Products

A.1 Product Summary

Product	Description	Product Link
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://dx.doi.org/10.4225/25/5a7a501e1c5af
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://dx.doi.org/10.4225/25/57D8DD73A42B5
Water Observations from Space	A summary of surface water observations derived from Landsat imagery for all of Australia from 1987 to the present.	http://dx.doi.org/10.4225/25/5487D7B920F51
Fractional Cover	A 25m x 25m footprint of the proportions of living vegetation, dry/dying vegetation and bare soils across Australia.	https://ecat.ga.gov.au/geonetwork/srv/eng/search#!fef25026-23be-474a-9e72-52fdfb7c2cf6
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://dx.doi.org/10.4225/25/5a602cc9eb358
High and Low Tide Composites	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://dx.doi.org/10.4225/25/5a615705d20f7
Dynamic Land Cover Dataset	Nationally consistent and thematically comprehensive land cover reference for Australia.	https://ecat.ga.gov.au/geonetwork/srv/eng/search#!19b3b236-e0aa-d2fb-e053-10a3070af790
Geomedian	High-dimensional, continental-scale pixel composite mosaics for landscape characterisation.	https://doi.org/10.1109/TGRS.2017.2723896
Mangrove Canopy Cover	A national map of mangrove canopy extent.	https://nationalmap.gov.au
Barest Earth	A national composite image representing the barest (i.e., least vegetation) state for each Landsat pixel across Australia.	https://nationalmap.gov.au
Multi-Scale Topographic Position	A national multi-scale topographic position image of Australia generated by combining a topographic position index and topographic ruggedness.	https://nationalmap.gov.au

Weathering Intensity	A national composite image representing the degree of weathering for every point in Australia	https://nationalmap.gov.au

Appendix B Document Control

B.1 Changelog

Revision Date	Change Location	Change Description
November 2018	Section 2, Projects	Added ‘Product Development Approach’ Added ‘Users’ Updated ‘Project Partners’ Removed ‘Project Documentation’
	Section 3, Land Cover and Land Use	Changed ‘Partners’ to ‘Working with’ in all project tables Updated ‘Partners’ across all Current and Horizon project entries Added change detection content to section overview Added ‘Fractional Cover Percentiles’ to Current Projects Added ‘Crop and Dam Mapping’ to Current Projects Added ‘NDVI Percentiles’ to Current Projects Added ‘LCCS National Product’ to Current Projects Added ‘Tasselled Cap Statistics’ to Current Projects Added ‘Barest Earth’ to Current Projects Added ‘Urban Feature Classification’ to Current Projects Added ‘New Approaches to Statistical Analyses of Time Series Data’ to Current Projects Added ‘Burn Extents’ to Current Projects Added ‘Wetlands Characterisation’ to On the Horizon Completed ‘Un Land Cover Classification System Feasibility Study’. Removed from Current Projects. Completed ‘Dynamic Land Cover Dataset’. Removed from Current Projects. Completed ‘Irrigated vs Non-irrigated Crop Extents’. Removed from Current Projects. Removed ‘National Intertidal Digital Elevation Model’ from On the Horizon. Added to Current Projects in Section 4, Marine and Coastal Removed ‘Broad Commodity Type Crop Mapping’ from On the Horizon Removed ‘NEXIS Enhancement’ from On the Horizon

Revision Date	Change Location	Change Description
		Removed ‘National Wetlands Extents Map’ from On the Horizon Removed ‘Urban Features’ from On the Horizon Moved ‘Forest Cover’ from Current Projects to On the Horizon Moved ‘Water Quality Monitoring for Sustainable Development Goals’ to On the Horizon Moved ‘NRM Requirements Analysis’ from On the Horizon to Section 10, Industry and Community Engagement, Current Projects.
	Section 4, Marine and Coastal	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Updated ‘National Mangrove Mapping’ Added ‘National Intertidal Extents Digital Elevation Model’ to Current Projects Added ‘Coastal Change Characterisation’ to Current Projects Added ‘ Ocean Colour Statistical Summary’ to Current Projects Added Sea-Surface Temperature Statistical Summary’ to Current Projects Removed ‘IMOS Products’ from On the Horizon Removed ‘Marine Turbidity’ from On the Horizon Removed ‘Ocean Colour Statistical Summary’ from On the Horizon Removed ‘Sea-Surface Temperature Statistical Summary’ from On the Horizon Removed ‘Coral Bleaching’ from On the Horizon Removed ‘Coastal Change Characterisation’ from On the Horizon
	Section 5, Analysis Ready Data	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Removed ‘Change Detection’ section. Merged all current content into Section 3, Land Cover and Land Use Renumbered Section 5, Analysis Ready Data Added ‘Analysis Ready Data – Production Code Upgrade’ to Current Projects Added ‘Landsat Surface Reflectance Near Real Time Service’ to Current Projects Updated ‘Surface Brightness Temperature Validation” Updated ‘Surface Reflectance Validation’ Added ‘National Surface Deformation’ to Current Projects Added ‘Sentinel-2 Cloud Masking’ to Current Projects Added ‘MODIS Indexing’ to Current Projects Added ‘Evapotranspiration’ to Current Projects Added ‘SAR Analysis Ready Data Development’ to Current Projects Completed ‘Observation Density Quality Assessment’. Removed from Current Projects. Completed ‘Improving the Location Accuracy of Synthetic Aperture Radar’. Removed from Current Projects. Removed ‘Sentinel-1 ARD’ from On the Horizon Removed ‘MODIS ARD’ from On the Horizon

Revision Date	Change Location	Change Description
		Removed ‘VIIRS ARD’ from On the Horizon Removed ‘Evapotranspiration’ from On the Horizon Added ‘ Improved Landsat Cloud Mask’ to On the Horizon Added ‘Assess Quality of USGS LST Products’ to On the Horizon
	Section 6, Platform Improvement	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 6, Platform Improvement Added ‘Enhanced API Access’ to Current Projects Added ‘Spatio-Temporal Asset Catalogue’ to Current Projects Updated ‘Architecture Documentation’ in Current Projects
	Section 7, Data Visualisation and Delivery	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 7, Data Visualisation and Delivery Added ‘Jupyter Hub’ to Current Projects Added ‘ODC Web Processing Service Development’ to Current Projects Added ‘ODC WCS Development’ to Current Projects Added ‘Data Dashboard’ to Current Projects Completed ‘User Experience Design’. Removed from Current Projects. Completed ‘GSKY Services for National Map’. Removed from Current Projects Removed ‘Virtual Products’ from On the Horizon Removed ‘Web Processing’ from On the Horizon Removed ‘Data Dashboard’ from On the Horizon Added ‘S3 Save’ to On the Horizon
	Section 8, Data Management	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 8, Data Management Added ‘Landsat Collection Upgrade’ to Current Projects Added ‘Copernicus Australia Regional Data Hub’ to Current Projects Completed ‘Automation of Landsat Processing Pipeline’. Removed from Current Projects Completed ‘Cloud Computing Architecture Pilot’. Removed from Current Projects Completed ‘Regional Copernicus Data Hub Development’. Removed from Current Projects Removed ‘Collection One Upgrade’ from On the Horizon Removed ‘DGGS Support’ from On the Horizon Removed ‘DGGS Implementation Support’ from On the Horizon Removed ‘Near Real Time Landsat Processing’ from On the Horizon Added ‘Asia-Oceania Data Hub’ to On the Horizon

Revision Date	Change Location	Change Description
	Section 9, Government Engagement	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 9, Government Engagement Added ‘Murray Darling Basin Authority’ to Current Projects Added ‘Seasonal Conditions Update for NSW DPI Agriculture’ to Current Projects Completed ‘Department of the Environment and Energy Needs Analysis’. Removed from Current Projects Removed ‘Tasmanian Government Transition to DEA’ from Current Projects Added ‘Tasmanian Transition’ to On the Horizon Added ‘Marine Product Extension’ to On the Horizon Added ‘FC and S2 FC for DAWR for GEOGLAM-RAPP’ to On the Horizon Added ‘ABS Using DEA’ to On the Horizon Added ‘WA Salinity Mapping / WA Enablement’ to On the Horizon Added ‘DEA Products in DoEE Wylie’ to On the Horizon Added ‘Mangrove Update by NCAS’ to On the Horizon Added ‘Prototype Products for Drought Response’ to On the Horizon Removed ‘Inter-departmental Grad Program’ from On the Horizon
	Section 10, Industry and Community Engagement	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 10, Industry and Community Engagement Updated ‘Industry Strategy’ in Current Projects Added ‘Natural Resource Management Regions Requirements Analysis’ to Current Projects Removed ‘FarmMap4D Need Analysis’ from On the Horizon
	Section 11, International Engagement	Changed ‘Partners’ to ‘Working with’ across all project tables Updated ‘Partners’ across all Current and Horizon project entries Renumbered Section 11, International Engagement Added ‘Digital Earth Africa’ to Current Projects Added ‘Mekong ODC’ to On the Horizon
	Appendix A, Products	Added ‘Geomedian’ to A.1 Product Summary
	Appendix B, Document Control	Removed Appendix B Projects content Renamed Appendix B to Document Control Added B.1 Changelog Renumbered B.2 Glossary

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
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.
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.
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
DAWR	Department of Agriculture and Water Resources (AUS)
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)
DLCD	Dynamic Land Cover Dataset
DoEE	Department of the Environment and Energy (AUS)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (TAS)
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)
UK	United Kingdom of Great Britain and Northern Ireland
UK Catapult	UK Satellite Applications Catapult. UK-based technical development company.
UN	United Nations
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.
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.