

Digital Earth Africa (DE Africa)

Implementation Plan for GEO Initiative (Currently GEO Community Activity) 2020-2022 GEO Work Programme

1. Executive Summary

Digital Earth Africa (DE Africa) aims to improve the lives of Africans by providing planners and policy makers with tailored Earth observation information to support better decision making and enhance sustainable development outcomes.

DE Africa (Phase II, 2019 – 2022) aims to establish DE Africa as an African-based and managed operational platform, funded by the Australian Government Department of Foreign Affairs and Trade (DFAT), and The Leona M. and Harry B. Helmsley Charitable Trust (Helmsley).

From 2021, the focus will be **to transition** DE Africa capabilities and functions to Africa, and **sustainment**, in terms of governance, management and resources. There will also be a continued focus on “growing the ecosystem of users” across government, industry, private and community sectors.

To achieve this DE Africa will continue to deliver Earth observation products that meet development needs and can be applied to real world development challenges. It will also continue capacity development, to support and strengthen local networks of users to collaborate and work together to better understand and be able to access and use DE Africa.

Summary of Planned Activities

[DE Africa Annual Plan](#) is guided by operational requirements, DE Africa’s [Governing Principles](#), and long-term program outcomes. Within this overarching program framework, the effort will be focused to deliver the following key objectives:

- **Achieving a fully operational Governance Framework.** This will see coordination of the Governing Board meeting to review and provide guidance on strategy, risks, and performance. The Technical Advisory Committee will continue to provide critical advice.
- **Transitioning functions to Africa.** This means establishing the Program Management Office and formalising the roles of Implementing Partners so that they can progress critical engagement, capacity building and uptake with end-users.
- **Establish and transition technical operations.** This includes completing the establishment of an operational platform and operational data pipelines in AWS Cape Town, and transition of significant skills, program knowledge, insights and expertise.
- **Securing additional investment.** Additional funding needs to be secured in a timely manner to ensure ongoing delivery beyond the program’s Establishment Phase. The program will pursue a range of strategies to support this priority.
- **Developing capacity across Africa.** A core element of the DE Africa program is to develop

sustained capacity which is both based and built in Africa.

- **Delivering and demonstrating impact.** The Team will work with a growing range of users to apply DE Africa platform data and products to their needs, and collate evidence of use, impact and benefits.
- **Partnerships and community.** DE Africa is built on partnerships to create sustained capability development in Africa. We will continue to strengthen existing partnerships and form new relationships where needed to progress our objectives.
- **Awareness.** Success for DE Africa will depend not only on uptake and impact, but on there being a broad awareness of the relevance and importance of this capability for Africa. Increased investment in communications will see implementation of the new communications strategy with the objective of building buy-in, engagement and uptake.

Point of Contact - Adam LEWIS (Geoscience Australia/Australia) adam.lewis@digitalearthafrika.org

2. Purpose

The Data Cube (www.opendatacube.org) was first developed and operationalised in Australia (www.ga.gov.au/dea), where it is transforming the use of earth observations in government decision-making and private sector innovation. Digital Earth Africa (DE Africa) is developing a continental-scale Data Cube for Africa, providing a routine, reliable and operational service enabling African nations to track changes across countries in unprecedented detail. With a land area of over 30 million square kilometers, DE Africa is now the world's largest continental Data Cube. DE Africa products and services are available to enable policy makers, scientists, private sector, and civil society to address social, environmental, and economic changes on the African continent and develop an ecosystem for innovation. DE Africa is leveraging and building on existing capacity to enable the use of Earth observations to address key challenges across the continent.

DE Africa is contributing to the following international policy priorities, which also underpin the GEO Strategic Plan:

- United Nations 2030 Agenda for Sustainable Development;
- Sendai Framework for Disaster Risk Reduction; and
- Climate Change, with specific emphasis on the Paris Agreement
- The African Union's Agenda 2063 – "the Africa We Want"

[DE Africa Technical Roadmap](#) describes the technical work program in detail. DE Africa offers the following products and services:

- (i) **Input Datasets** are the foundational CEOS Analysis Ready Datasets and ancillary data that can be used to derive output services and accessed directly through the DE Africa Platform. Following input datasets are prioritized and developed to achieve operational workflows.
 - a. Surface Reflectance and Surface Temperature Landsat Collection 2
 - b. Surface Reflectance Sentinel-2

- c. Normalized Radar Backscatter Sentinel-1
 - d. Following datasets will be maintained and updated when necessary:
 - i. Digital Elevation Model SRTM
 - ii. Normalised Radar Backscatter ALOS/JERS Annual Mosaic
- (ii) [DE Africa Platform](#) includes infrastructure and tools that support data visualisation, discovery and analysis and enable users to interface with DE Africa data and services. It includes the following components.
- a. **Earth Observation Data Lake** - includes all datasets that make up the Analysis Ready Data and DE Africa Services, open for public access.
 - b. **A 'Sandbox' environment** based on JupyterLab, accessible to users for open source scientific notebook development. It includes an ODC environment pre-loaded with all of the Earth observation data in DE Africa, enabling users to immediately start performing interactive analysis on the data without downloading or processing the raw data.
 - c. **DE Africa Metadata Explorer** enables non-expert users to find specific datasets through time and space as well as query metadata related to each dataset.
 - d. **DE Africa Map Service** enables users to visualise and download geospatial datasets in a web browser. It is built on Terria.JS, which is an open source and freely available software. Users can integrate their own data and services with remote-sensing data.
 - e. **The Africa Geoportal**, powered by Esri using ArcGIS online, provides users with data, tools and support in visualising, discovering and analysing different aspects of Africa, drawing on data from DE Africa. Access is free to those residing in Africa or working on projects within Africa.
- (iii) [Services](#) are the information products derived from Input Datasets. An operational service is continuously updated as required input datasets become available. Services may be updated, based on user feedback, to incorporate new sensors, new algorithms and auxiliary data. Planned services are listed below:
- a. **Geomedian annual images** provide seamless coverage over the whole continent with minimum impact from cloud. It enables easy visual and algorithmic interpretation, e.g. understanding urban expansion, at annual intervals. They are also useful for characterising permanent landscape features such as woody vegetation.
 - b. **Median Absolute Deviation** to characterise and measure change in the landscape. This service can be used in machine learning for change detection, land cover mapping, and environmental monitoring. Detecting seasonal variation supplements long-term decision-making by policy makers and industry with short-term, cyclical environmental management considerations.
 - c. **Water Observations from Space (WOfS)** allows users to understand the location and movement of water present in a landscape. 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. Summary products can be used to understand long term changes in the landscape and water availability and flooding risk in a historical context.
 - d. **Food Security - crop land map** identifies areas that have been cropped in a given year. A consistent up-to-date crop land mask for the continent would assist in implementing the GEOGLAM crop monitor program.

- e. **Seasonal fractional cover** 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 surface process monitoring, land management practices, vegetation studies, fuel load estimation, ecosystem modelling, and rangeland condition.
- f. **Illegal mining activities** can be identified by performing change detection on optical surface reflectance and normalised radar backscatter data. This information is useful to develop targeted initiatives across government and industry that reduce illegal mining to strengthen countries' economies.

Why DE Africa?

DE Africa products and services offer several advantages compared to the status quo approach, such as:

- free access to analysis ready data, open source algorithms and access to compute to undertake regional, national or local scale analysis, as defined by end users area of interest.
- access to cloud free composite products such as Geomad, which saves lot of and effort for individual users at project level, following the traditional approach.
- access to continental scale thematic products such as WOFs, crop mask, fractional cover products – all calibrated and validated to local conditions, hence increased confidence for end users.
- continental products would enable development of regional models by our partners such as IWMI, SERVIR, GeoGLAM, etc. related to water accounts, drought forecast, crop monitoring, etc.
- DE Africa partnership with tech giants such as AWS, ESRI etc. brings additional tools and capabilities, otherwise not easily accessible to individual countries, such as DE Africa Geoportal, to be launched in May 2021, will allow users to develop web map applications and share their results with local users, pretty quickly, at no cost.
- necessary training and capacity development activities offered by DE Africa would allow end users to make best use of DE Africa products and services, much more efficiently.

Therefore, based on experience from Australia, DE Africa would offer significant productive gains and rapid uptake of EO data to solve problems. The focus will be on the applications and problem solving rather than spending lot of time on data handling and processing.

The following table provides a high level summary of key user groups and how they intend to use DE Africa products and services to support their organisations. This is not a complete list of users, however, it shows a cross section of users, expected to benefit from this initiative.

Table 1. High level summary of DE Africa user groups and intended uses

User Group	Example Users	Intended Uses
Implementing Partners	AFRIGIST - Nigeria AGRHYMET –Niger CSE - Senegal OSS - Tunisia RCMRD - Kenya SANSa - South Africa Others who will join in future	Staff from these institutes will have direct access to the platform and services to tailor solutions specific to their projects or community of users. Activities include staff training, product development and testing, validation, communications and outreach.
Government and	Agencies, such as the UNECA	Undertake data analysis and extract

Intergovernmental agencies in Africa	dealing with agriculture, statistics, environment, climate change, digital transformation and education sectors	relevant thematic and statistical information to support internal projects. Support staff learning and development activities. Communication and outreach activities including demonstration of use cases.
NGOs and Charity Organisations	GPSDD, B2P, etc.	Use of DE Africa products and services will open new applications and new ways of reaching out to users in Africa.
Aligned Partners	GEOGLAM, AFRIGEO, SERVIR, IWMI, University of Twente-ITC	Program alignment will allow these long-standing, well established initiatives to take full advantage of DE Africa technology, products and services, to deliver better and faster services to African users, avoiding duplication. Equally, DE Africa is able to leverage the knowledge base, capabilities and services of aligned programs such as the Collect Earth Online tool developed by SERVIR.
Private sector	As part of DE Africa Industry Engagement Strategy, about 70 African based companies have been approached to explore opportunities to develop value-added services using EO data in Africa	Develop innovative value-added services to meet private and public sector demand for information services.
Students and education sector	Higher secondary and tertiary educational institutes in Africa	Teaching and research purposes. DE Africa online learning material, supplemented by weekly training sessions is already proving to be hugely successful in training students, equipping them with employable skills. These students will rapidly become the new source of expertise and advocacy for the application of EO in Africa.
International aid partners	E.g. AusAID, USAID, UKAID, GIZ, etc.	Future projects can leverage DE Africa infrastructure, institutional arrangements and trained staff to deliver program outcomes more quickly and efficiently.
Entrepreneurs and innovators	Startup companies	Open access to DE Africa platform and software tools promotes startup culture, makes it easy to test ideas and develop prototypes to demonstrate value proposition. Enables cloud based digital services.

DE Africa is working with Amazon Web Services (AWS) to ensure the best service/cost availability to store, process and interact with DE Africa. AWS is a world-leader for cloud based computing, and working with AWS improves DE Africa's core infrastructure that enables the scope of DE Africa to reach the entire African continent.

DE Africa is working with African stakeholders to attain and utilise [calibration and validation data](#), along with in-situ data, required for improving the quality of satellite data utilised by DE Africa. Without this collaboration, Earth observation insights delivered by DE Africa would be limited by significant uncertainties in the findings and modelling.

DE Africa will deliver the following outcomes in Africa:

- Countries are empowered, with national data and information relating to challenges of land, water, the environment, resources, and human population.
- Lives are improved, through access to information that empowers governments, individuals and communities to make informed decisions and choices.
- Development activities are more effective, through access to and use of information that improves the understanding of issues and solutions. Continental assessments, reporting, and responses are advanced through access to continental scale data and information products relevant to Agenda 2030 and the Sustainable Development Goals.
- Digital transformation is advanced, through industry uptake and innovation using products and services from DE Africa.
- Economic development and job creation are increased, through access to data for commercial products and services development.

3. Background and Previous Achievements

DE Africa is an existing GEO Community Activity within the [2020-2022 GEO Work Programme](#).

[DE Africa Phase 1 report](#) provides background information and summary of work completed by early 2019, demonstrating the value proposition of Earth observations data to support economic and environmental development in Africa. DE Africa [2021 Annual Work Plan](#) is currently being finalised and is expected to be published in the next few weeks. [2020 Annual Report](#) provides a detailed list of achievements of DE Africa. A brief summary of key achievements is given below.

Technical Infrastructure, Products and Services:

- ✓ Established the infrastructure to process and [store data at AWS Africa \(Cape Town\)](#), enabling a more secure, stable and better performing platform for African users, in collaboration with Amazon Web Services through a 'tech for good program'
- ✓ Progressed implementation of the [DE Africa Technical Road Map](#) by establishing its first free and open, analysis ready, continuous updated satellite dataset for all of Africa, accessing data from [Sentinel-2](#) satellites. [Sentinel-1](#) and [Landsat](#) datasets are on track to follow early 2021
- ✓ Significant progress has been made in the development of continental scale, quality assured and locally validated data products that support planning and decision making around water management (Water Observations from Space), food security (Cropland Map) and a cloud-free, 10 meter resolution image of all of Africa (Geomedian). Products are being co-developed with representatives from six African Implementing Partners.

- ✓ Products and services are available through a range of [DE Africa platform interfaces](#) ensuring ease of access to a diverse range of users, from those with no technical expertise, to a highly qualified systems developer who can access live code to create and share their own products.
- ✓ For the first time in Africa, DE Africa is on track to routinely process Copernicus [Sentinel-1 radar data](#) for the entire continent by early 2021. Radar satellite imagery is important for Africa as it is not affected by cloud cover. The dataset spans back to 2017 and will be updated every 12 days, totaling approximately 50,000 scenes every year.
- ✓ Work has also progressed towards the routine processing of United States Geological Survey (USGS) [Landsat 5, 7 and 8](#) data for all of Africa, expected to be operational in 2021.

DE Africa Platform Services:

- ✓ In 2020 DE Africa implemented the following services, accessible through multiple pathways, enabling use by a diverse range of people, from those with no technical expertise, to a highly qualified systems developer who can access live code to create and share their own products.
 - [DE Africa Map](#) - a website for map-based access to spatial data providing easy access to DE Africa decision ready data for non-technical users.
 - [DE Africa Sandbox](#) – a cloud based user computational platform that provides advanced users with access to data and analysis tools, for regional scale analysis. About 300 users registered to use this service in 2020, which has grown significantly since.
 - [Africa GeoPortal \(Esri\)](#) - web GIS and geodatabase management application supplying DE Africa data.

Growing User Demand and Uptake:

- ✓ Completed the World Economic Forum (WEF) analysis of the [potential economic value of Digital Earth Africa products](#).
- ✓ Transitioned 45 African Regional Data Cube (ARDC) users from 6 countries to the DE Africa platform following a self-paced six-week training program and successfully decommissioned the African Regional Data Cube.
- ✓ Held a webinar on [Capacity Development](#), including a panel discussion consisting of representatives from RCMRD, Observatory Sahara Sahel (OSS), AGRHYMET and AFRIGIST. There were **94 attendees, with representation from 19 African countries**.
- ✓ Delivered [6-week self-directed training program](#) to support new users engage effectively with DE Africa data and products. The training material is available online for all to access, opening the way to a larger scale in-country capacity development program with DE Africa Implementing Partners in Africa
- ✓ Providing weekly live sessions, and tailored user communication and responsive support, for example via WhatsApp discussion groups, to active DE Africa platform users. This is supporting user engagement with DE Africa products to address real-world development challenges.

Gender Equality, Diversity and Social Inclusion:

- ✓ In 2020 DE Africa developed its first [Gender Equality, Diversity and Inclusion \(GEDSI\) Strategy](#), which gives effect to its Guiding Principle to be an exemplar of diversity and inclusiveness.

Partnerships and Outreach:

- ✓ In 2020, the [Communication Strategy](#) was deployed to support and enable Digital Earth Africa's Program objectives. DE Africa has strengthened engagement with the Earth observation and development community across Africa, enhancing awareness and profile, and creating opportunities for alignment and collaboration.
- ✓ Established over 17 technical, strategic and delivery partnerships with national, regional, and international organisations.
- ✓ DE Africa has featured in 12 externally authored articles in 2020; established a [new blog section](#) on its website to promote articles authored by experts.
- ✓ DE Africa has participated in over 16 major conferences, events and webinars, has over 2000 Twitter followers, and has had over 9000 unique web views since May 2020.

Institutional Foundations:

- ✓ Convened 3 Technical Advisory Committee meetings to continue to build awareness, buy-in, and African based ownership of the program. Developed and endorsed the nine institutional strategies and policies
- ✓ Successful recruitment of Africa based staff, [Dr Kenneth Mubea](#) (User Engagement Manager, Kenya) and [Edward Boamah](#) (Technical Manager, Ghana), who are facilitating greater contextualised and locally relevant engagement.
- ✓ Signed agreement with GEO as a trust fund manager, to support ongoing African based human resource and project support.
- ✓ Engaged an independent African based selection panel to undertake a comprehensive review of four proposals received by an interested party to host the DE Africa Program Management Office.

Challenges and Lessons Learned

2020 has been a challenging year for everyone in many different ways. Despite the limitations, restrictions and setbacks that have come with the COVID-19 pandemic, DE Africa has shown remarkable flexibility and resilience to continue roll out of the 'establishment' Phase II program. Where we have experienced challenges, the program has adapted and found new ways of working or applied new strategies to deliver outcomes.

For example, progress towards establishing the institutional host has been slower than expected and faced some setbacks. In response we have pivoted our approach and adopted a more flexible dispersed model which facilitates the networks, reach and capacity of regional partners across Africa. Reflecting on 2020, we have gained significant experience and learned lessons along the way:

- Building awareness and professional relationships with and across the Africa user community is key to growth in uptake and application. Through this establishment phase we need to continue to provide consistent, timely, responsive and clear advice, information and support. Notwithstanding continuing COVID-19 travel restrictions, DE Africa needs to continue to build local networks. Accelerated growth in the Africa based team will assist with this.
- We need to continue to sharpen our communications about what DE Africa is and how it can benefit the governments, industry and people of Africa. African decision makers want to know how DE Africa is of benefit to the communities they work for – it is incumbent upon the program to define and communicate the potential value and benefits.
- We have proven the technical feasibility of DE Africa and made significant progress in establishing the technical platform, but we must turn focus to growing and better understanding the various applications, impacts and benefits.

4. Relationship to GEO Engagement Priorities and to other Work Programme Activities

With a land area of over 30 million square kilometers, DE Africa will be the world's largest open data cube to provide insights into a range of issues including flooding, drought, soil, coastal erosion, agriculture, forests, land use and change, water availability and quality, and changes to human settlements. In particular, the use of EO within Africa will be directly relevant to SDGs 2 (zero hunger), 6 (clean water and sanitation), 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 13 (climate action), 14 (life below water) and 15 (life on land).

Table 2. DE Africa contribution to the SDGs (from [WEF report 2021](#)).



Farmers can monitor their land vegetation to improve outlooks on crop production, ensure the anticipation of food volumes are accurate and identify potential food shortages early.



Communities can better understand changes of water extent and quality in dams, wetlands, rivers and other water bodies due to floods and droughts to improve their water management.



Companies, small business and entrepreneurs will have access to analysis-ready EO data to develop new applications, many of which are yet to be realised.



City planners can track the movement of people based on land settlement changes over time to understand where urbanisation is occurring.



Countries can measure and monitor the environment to develop and implement climate adaptation and mitigation plans.



Communities can monitor water quality and assess the conditions and impact on marine life to improve inshore management.



Countries can monitor, track and report on forest cover for more sustainable forest management.

Table 3. DE Africa relationship with the 2020-2022 GEO Work Programme.

GEO Work Program	Current Status	DE Africa Contribution
GEO-Secretariat	Relationship established	Agreement in place with GEO for trust fund management. The fund will provide ongoing African based human resource and project support for 2021 and beyond.
GEOGLAM	Relationship established	Held meetings with the GEOGLAM team. DE Africa Implementing Partners are using the Platform to generate crop map, including collection of field data to train the algorithm and validation of final outputs. This data then becomes an essential input to the GEOGLAM crop modelling and reporting in Africa.
AFRIGEO	Relationship established	AFRIGEO, as a member of the DE Africa Technical Advisory Committee, contributing to the work program and guiding it to ensure AFRIGEO stakeholders are fully aware and make use of the DE Africa resources to achieve objectives of mutual interest.
GFOI	Relationship established	Both GFOI and DE Africa are funded by the Australian government in support of global action on climate change and the Paris Agreement. We will be working closely to maximize mutual benefits from these two initiatives.
GEO-Wetlands	Connection to be established	Australian scientists in collaboration with the international researchers have developed algorithms using open data cube technology which will be implemented on DE Africa Platform, in collaboration with the west African countries, who have expressed interest. Outputs from DE Africa will contribute to the global wetlands monitoring and the International Partnerships for Blue Carbon (IPBC).
GEO Essential Variables	Connection to be established	Continental scale, high resolution thematic outputs such as water observations from space, water summary, crop map, fractional cover, etc., produced and validated by African agencies will become input variables to continental and global models related to water, ecosystem and carbon accounts.
GEO Land Degradation Neutrality	Connection to be established	Continental scale, high resolution thematic outputs such as fractional cover, water observations, crop maps, etc., produced and validated by African agencies will become inputs to continental and global models related to land degradation.
GEO BON	Connection to be established	DE Africa provides continental scale, interoperable, validated thematic inputs (Essential Variables), useful to the GEO BON user community.

5. Stakeholder Engagement and Capacity Building

Partnerships and collaborations underpin the successful deployment of DE Africa. Stakeholder engagement is undertaken through a range of activities and strategies specifically tailored, such as

[Communication Strategy, Partnership Strategy, Alignment Strategy, Data Validation Strategy, and Gender Equality, Diversity and Social Inclusion Strategy](#). DE Africa stakeholders can be grouped into the following categories:

- A. **Implementing Partners:** As part of a distributed operational model, established African agencies listed in Table 1, will be implementing DE Africa work programs including product development, and capacity development, to support country specific needs.
- B. **Technical Partners:** Such as Amazon, ESRI, etc., will be providing in-kind contributions and capacity development to enable better use of DE Africa products and services.
- C. **Aligned Partners:** DE Africa is developing collaborations with the existing programs in Africa providing specialist services such as International Water Management Institute (IWMI), SERVIR, etc. This will not only avoid duplication of effort, but most importantly adds value to the existing programs by providing additional services, compute resources, analysis ready datasets with easy access to users in Africa.
- D. **Industry partners:** DE Africa is working with Frontier SI to identify industry partners based in Africa who can develop innovative, value-added solutions to private and public sector clients in the region.

DE Africa is an open data infrastructure and program that serves geospatial products and services for the entire continent. The approach creates opportunities for users from over 50 countries, and across all sectors, to leverage and create value from Earth observation data. User engagement is starting to occur across sectors and across a range of user types from remote sensing scientists and developers to government officials, journalists and the lay person. As such a holistic capacity development program is being developed to empower this user base.

DE Africa capacity building is guided by the [Capacity Development Strategy](#), developed and endorsed by the Technical Advisory Committee (TAC) in February 2020. DE Africa has partnered with [ITC](#) to develop and implement the capacity building Strategy.

The Strategy aims at guiding the roll-out of the DE Africa program, supported by pre-defined principles and a CD operational framework consisting of a set of strategic pathways to achieve impact. As identified during the workshop in March 2020 in Pretoria, several strategic pathways (Table 4) were identified and prioritized as the core activities to deliver. Implementation is driven by co-design where partner organisations assist in the delivery of fit-for-purpose capacity building activities. Train-the-trainers is the core pathway for the CD strategy and this will be delivered through partner institutions in Africa with the specific mandate to support this work.

Table 4. Key Strategic Pathways to roll out capacity building activities in Africa

STRATEGIC PATHWAY	INPUT	ACTIVITIES	OUTPUTS	OUTCOMES
-------------------	-------	------------	---------	----------

Training of Trainers	Methodology for organisational and individual needs assessment Technical and didactic /pedagogic expertise (DEA Office, GA, partners)	Organisational and individual needs assessment Development of a ToT curriculum / Development of didactic materials	Staff of Implementing Partners & Regional Official Statistics Offices, trained	Regional centers strengthened to design & deliver targeted training to national institutions
Training of end-users	Expertise from regional centers, knowledge institutes, Overview of existing training opportunities	Development of training modules in different delivery formats	Proper uptake of DE Africa data products and tools for decision-making, policy and action	National public and private institutions strengthened
Awareness Training	Expertise from DE Africa, GA, Thunderbird, Governing Board and TAC	Providing decision-makers with information and tools needed for the implementation of the DEA program at the continental, regional and national level	Decision- and policy makers aware of the benefits of the DE Africa data products for proper decision making	Uptake of the DE Africa program, analysis ready data set and applications by decision- and policy makers of pre-selected institutions
Alignment with GEO	Expertise from DE Africa, secondment at GEO. Expertise from GEO flagships and Initiatives	Identification of user cases and case studies Development of applications and tools	User cases and applications adopted by GEO flagships and Initiatives	Better use of ARD in monitoring focus areas of the GEO flagships and Initiatives
Innovation and entrepreneurship	Expertise from DE Africa, Expertise from renowned private companies, incubators and innovation hubs	Provide small businesses and industry to more readily access satellite data and knowledge to innovate and create new products and services	Private sector strengthened and new businesses established using EO data and ARD for service provision	Creation of new jobs in the GEO field
On the job coaching	Expertise of DE Africa	Provide on-the-job coaching to ensure uptake of data products	Use of data products for decision- & policy making	Regional, national public and private institutions strengthened
Alignment with other platforms and initiatives	DEA secondment at GEO DEA GB and TAC	Sharing of technologies, expertise, data sets, tools and applications with other platforms and initiatives	Alignment with other platforms, initiatives, projects, implemented at the subnational, national and regional levels	Reduction of required financial resources Increase of available data sets

Community of Practice	DEA office DEA Stakeholder Community	Establishing a CoP and sharing platform on products, tools, experiences, showcases, case studies	Continuous learning at organization level	Partner organisations strengthened
------------------------------	--	--	---	------------------------------------

To date, the following activities have been implemented through the DE Africa capacity building strategy.

- Co-design a 6-week DE Africa user training course, now available for anyone to access. The course was first used to transition users from the pilot Africa Regional Data Cube (ARDC).
- Transition of all users to the DE Africa Platform.
- Growth in users from ~10, to over 500, during the second year of the program.
- Evidence of capacity development impact, with emergence of champion users and independent development of use-cases.
- Six Implementation Partners engaged, and their training support needs established.
- Over 300 registered Sandbox Users, 20 + Notebooks, and over 4 ‘use cases’ demonstrating applicability to real-world development challenges.

6. Governance

A governance framework has been established for DE Africa inclusive of a Governing Board, Technical Advisory Committee and Stakeholder Community Group (<https://www.digitalearthafrika.org/about-us/governance>).

The [Technical Advisory Committee \(TAC\)](#) is well established in driving the work program to achieve the program objectives. The TAC has convened seven times to March 2021. The Governing Board is still in development with plans for launching the Board in the second quarter of 2021.

The role and memberships of the Governing Board and the TAC memberships is below:

Governing Board

The Governing Board will provide strategic guidance, oversight and accountability to ensure successful achievement of the mission and vision of DE Africa. It will meet twice a year. Board members will be at a high level and will serve as Champions for the program. Inaugural Board Members include GEO, the World Economic Forum and the Africa Union Commission with high level representatives from the government of Rwanda, Tanzania, and Geoscience Australia.

Technical Advisory Committee

The Technical Advisory Committee (TAC) brings together subject-matter-experts who can provide rigorous and practical guidance on the overall technical program for DE Africa, including user needs and alignment with other programs across Africa. Its members are experts and practitioners who provide guidance on how DE Africa data can be applied across a broad range of sectors. The TAC currently has 18 members drawn from across Africa and the broader international community. The TAC is co-chaired by members from African institutes. [TAC members can be found here.](#)

Project Management Office (PMO)

A Project Management Office (PMO) is being established in Africa to transition operations and management of DE Africa going forward. Following a successful request for proposals process, we are currently negotiating contract with the successful applicant. The contract schedule includes a plan for transitioning the PMO to Africa and ensuring it is fully staffed within the next 6-12 months.

Monitoring and evaluation activities

DE Africa [Monitoring, Evaluation and Learning \(MEL\) Framework](#) has been developed to guide the collection, evaluation and use of data and information about DE Africa Phase II progress and results. The Framework:

- Describes the Phase II Investment Logic, including its Long-Term Goal, End of Phase Outcomes, Intermediate and Immediate Outcomes
- Defines the indicators and milestones that will be used to understand progress towards expected Outcomes
- Documents key data collection methodologies
- Describes the approach to evaluation, learning and adaptive management
- Details reporting requirements

The MEL Framework provides an overarching summary and is supported by a suite of documents that provide operational level detail.

Risk management

There are a range of risks associated with the delivery of Digital Earth Africa including a number of assumptions about how the project will work, and the context in which it will be delivered. A detailed Risk Management and Assumptions Monitoring Plan has been developed which identifies key risks and assumptions and sets out mitigation strategies and continued monitoring of these through the implementation of Digital Earth Africa Phase II. High level summary of risks and mitigation strategies are discussed below.

Table 5. DE Africa program risks and mitigation strategies

Risk	Description of Risk	Risk Management Strategy
Funding	Not securing adequate funding to support DE Africa beyond Phase II (the Establishment Phase).	Sustainability plan addressing funding requirements aligned with DE Africa's vision and mission, has been developed and is monitored by senior management. Monitoring and reporting of monthly expenses.
Delivery	Transition of technical and management functions to Africa delayed or not effective in achieving the DE Africa vision and mission.	Quarterly monitoring and reporting of achievements and issues, Results Frameworks, ongoing evaluation of services in line with the MEL strategy as

		part of the governance program.
User Capacity	Capacity building efforts do not result in long-term and valuable capacity for EO uptake and application.	Capacity Building strategy will focus on describing sustainable and effective strategies, with necessary interventions where required.
Stakeholder engagement	Difficulty achieving meaningful engagement with stakeholders including private sector, benefits of DE Africa products and services not fully realised.	Regular review of Results Framework will bring attention to strategic engagement priorities. Executive Director job description will include focus on strategic engagement, with further inputs from governance team.
Global pandemic	Remote working arrangements not fully effective in building good working relations.	Africa based staff to focus on relationships, effective use of digital connectivity tools, explore opportunities for in-person meetings where applicable.
Communications	Communication strategies do not result in sufficient awareness, understanding and profile.	User surveys and stakeholder feedback, review and update communication strategies that are not effective, engage Implementing Partners to reach out to regional groups, etc.

7. Resources

Summary of the estimated resources required to implement the proposed activities for the 2020-2022 period, including financial, in-kind participation, and other in-kind resources are listed below.

The ‘**Establishment Phase II**’ of DE Africa (2019 – 2022) aims to establish DE Africa as an African based and managed operational platform. This phase of the program is funded by the Australian Government Department of Foreign Affairs and Trade (DFAT) (\$9M AUD), and The Helmsley Charitable Trust (\$10M USD).

In addition, DE Africa activities to date have leveraged **in-kind contributions** from across the African continent and internationally, drawing other investments to support and align with the program and laying the groundwork for further investment in the program. Partner investment in the program to date includes:

- Amazon Web Services Sustainability Initiative is hosting 4 Petabytes of Landsat and Sentinel satellite data under its Public Dataset Program, at no cost to DE Africa
- Esri have contributed the Africa Geoportal site. This site allows a wider range of users to work with DE Africa data, using free-on-line tools
- US Geological Survey expedited the upgrade of provisional Landsat data for Africa to the DE Africa program
- University of Twente (ITC) co-funded the Capacity Development Strategy

- South African National Space Agency (SANSA) hosted the 4th Technical Advisory Committee Meeting
- Additional interested groups who have already expressed an interest in future close future alignment with DE Africa include:
- The International Water Management Institute (IWMI) has been funded through Helmsley to deploy modelling tools on DE Africa

Future funding – we are working with GEO and other partners to explore future funding options. Recently we engaged a consultant to undertake a detailed analysis of economic value of analysis ready data. This report is due by September 2021. Also, another report is in the pipeline, due by July 2021, to identify potential investors likely to fund this initiative beyond 2022. A sustainable funding strategy will continue to develop further mutually beneficial partnerships with a broad range of organisations and programs whose objectives and interests intersect with our own. These partnerships will further enhance DE Africa’s ability to leverage additional funds and other co-contributions, expanding the program scale and scope with increased benefits to Africa. This will ensure DE Africa is sustained as an on-going, African-based and African-led capability responsive to the information needs and priorities of the African continent.

Commercial sector engagement

Digital Earth Africa has partnered with [FrontierSI](#), [COOi Studios](#) and [NGIS](#) to undertake Industry Engagement Study in Africa. DE Africa’s [Industry Engagement Study](#) will provide vital insight into how African industry is engaging with satellite imagery, with a particular focus on African organisations that are working towards improving food security for the continent. The study will connect with both small businesses and larger-scale organisations who are using Earth observation data to identify the drivers and barriers surrounding the use of satellite imagery in the private sector. It will also seek out organisations that might benefit from incorporating EO into their practices. This report is due in June 2021.

8. Technical Synopsis

The [DE Africa Technical Roadmap](#) describes the technical work program in detail. This document outlines Input Datasets, the DE Africa Platform, and Services that will be utilised or produced. Each component can be related to the ODC workflow to ultimately develop Earth observation insights for decision-making.

CEOS Analysis Ready Data for Land (CARD4L) are Earth observation data that have 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. DE Africa will host CARD4L-compliant datasets. Landsat Collection-2 Surface Reflectance is providing the fundamental starting point for DE Africa and is expected to be the basis for the majority of the information products and services likely to be developed. Other crucial data sources are Sentinel-2, which provides more frequent and higher spatial resolution observations from 2015 onwards, and Sentinel-1, a radar mission of particular importance in areas where there is persistent cloud cover.

Ensuring CARD4L-compliance is essential to the Sustainability of DE Africa. DE Africa will work with satellite operators and encourage their efforts to routinely observe Africa, and to operational produce CARD4L-compliant data. This improves the sustainability of the DE Africa Program by removing the burden to produce and maintain bespoke approaches to data processing. It also ensures datasets are processed consistently to a high quality across Africa and are compatible with

global datasets. Through efforts coordinated by DE Africa in the longer term, users will be able to work with the global EO community to influence, improve and standardise processing techniques.

DE Africa will steadily increase the breadth and depth of its ARD collections with the addition of data from a range of satellites sensors and, in time, other sources of environmental data such as rainfall, stream gauge, radiometric, and surface climate data. DE Africa will offer the following datasets, as they measure key properties of the Earth surface and enable production and interpretation of other data products. They are compliant to or are being actively progressed to meet the CARD4L standards.

Landsat Surface Reflectance Collection 2

DE Africa has been working with USGS on the requirements of their collection upgrade known as Collection-2. DE Africa currently includes Provisional Collection-2 Landsat data. When fully operational in early 2021, this dataset will be updated automatically when a new upstream product becomes available and nominally within 10 days from acquisition. This data will provide continental scale coverage, enabling time-deep analysis going back 30 years in some cases (historic coverage is best in northern and southern Africa). It has a wide range of applications in helping to understand and monitor environmental changes.

Sentinel 2 Surface Reflectance

ESA's twin Sentinel-2 satellites, launched in 2015 and 2017, provide multi-spectral optical observations at a spatial resolution of up to 10 meters. Since early 2018, the pair of satellites have been acquiring images over most of the land surface every five days. This creates a time-deep data resource that can be used to inform a variety of services. Data will usually be added the day after it has been captured by the satellite. DE Africa is working with Sinergise, who manage the Sentinel-2 JPG2000 data in a collaborative arrangement with the ESA, to process entire African coverage.

DE Africa is also working with Element 84 to convert Sinergise's JPG2000 data for Africa to Cloud Optimised GeoTIFFS (COGs) – an open cloud native format that will enable greater accessibility for DE Africa's users. This data for Africa will be stored in a new AWS region in Cape Town. For further information, see: <https://registry.opendata.aws/sentinel-2/>. This data will provide high spatial and temporal resolution continental scale coverage, enabling characterisation and monitoring of land surface to support management of natural resources.

Normalised Radar Backscatter Sentinel-1

The DE Africa team is sourcing Sentinel-1 data according to CEOS CARD4L standards, and has funded development work for industry to be able to provide these products. When fully operational, this dataset will be updated automatically when a new upstream product becomes available and nominally within 3 days from acquisition. DE Africa has encouraged CEOS to make representation to the European Commission to provide ARD products as standard.

ESA's twin Sentinel-1 satellites, launched in 2014 and 2016, currently collect C-band SAR data every 12 days over Africa. Spatial resolution of the Sentinel-1 data is approximately 20m. Various efforts are underway world-wide to produce ARD products for Sentinel-1; for example, a CARD4L-compliant radar backscatter product is being developed in Australia. DE Africa has an opportunity to take advantage of these active developments and support updates of Sentinel-1 data in Africa.

Normalised Radar Backscatter ALOS Annual Mosaic

The global 25 meter resolution Phased Array-type L-band Synthetic Aperture Radar (PALSAR) and

PALSAR-2 mosaic is a free and open dataset generated from images obtained with Japanese L-band Synthetic Aperture Radars (PALSAR and PALSAR-2) on Advanced Land Observing Satellite (ALOS) and Advanced Land Observing Satellite-2 (ALOS-2). Annual mosaics are available for 2007 to 2010 and 2015 onwards. This is the first continental scale Synthetic Aperture Radar (SAR) ARD offered by DE Africa.

The ALOS/ALOS-2 PALSAR/PALSAR-2 mosaics are sourced from JAXA Earth Observation Research Center and reformatted for use in DE Africa. This dataset is updated when a new mosaic or a new version becomes available from JAXA. SAR data enables monitoring and detecting changes in the tropical regions where cloud-free optical coverage is sparse. It also provides complementary measurement to optical data and can be used to map land cover and changes, including surface water, urban areas, and vegetation.

Normalised Radar Backscatter JERS Annual Mosaic

The continental JERS-1 mosaic for 1996, obtained from the Japanese Earth Resources (JER) satellite, is sourced from JAXA Earth Observation Research Center and reformatted. This is a static dataset and will be updated when a new version becomes available from JAXA.

The 25 meter resolution JERS-1 mosaics were generated with the same method as the PALSAR/PALSAR-2 mosaics. In addition to the global mosaic for 1996, partial coverage is offered over tropical region in Africa from 1994 to 1997 and can be retrieved if required. This dataset extends the temporal coverage of L-band SAR data to be over 20 years, hence enable long term change detection, in particular over forested areas.

Digital Elevation Data

The SRTM (Shuttle Radar Topography Mission) v 3.0 (SRTMGL1) product obtained from NASA's Land Processes Distributed Active Archive Center and reformatted for use in DE Africa.

The Digital Elevation Model SRTM is a model providing topographical information, at 30 meter resolution, derived from data collected by NASA's SRTM in 2000. The Digital Elevation Model has been used as an input dataset for DE Africa. Topographic information is critical for understanding the land surface characteristics in the height dimension and supports land and natural resource management.

Other remote sensing, climate and ancillary geospatial datasets will be added progressively, based on user requirements.

9. Data Policy

DE Africa complies with the GEOSS Data Sharing Principles and GEOSS Data Management Principles and is a champion of open data, exemplified through its investment to develop 'pipe-lines' of open data for Africa. DE Africa relies on open data policy for all its inputs and output datasets. DE Africa Platform, Analysis Ready Data, Services and Analysis Tools and Training Material can be accessed from the website - <https://www.digitalearthafrika.org/>. All of the outputs, including Jupyter Notebooks are accessible under the Creative Commons Attribution 4.0 International. DE Africa is committed to ensuring digital accessibility for people with disabilities.

Tables (see attached excel document):

- A. Individual Participants
- B. Confirmed Contributions
- C. Task / Work Package Structure
- D. Deliverables / Milestones

Annexes

I. Acronyms and abbreviations

<u>Term</u>	<u>Definition</u>
ALOS	Advanced Land Observing Satellite
ARD	Analysis Ready Data
ARDC	African Regional Data Cube
AWS	Amazon Web Services: Cloud computing infrastructure provided by Amazon (United States).
CARD4L	CEOS Analysis Ready Data for Land
CEOS	Committee on Earth Observations Satellites
DE Africa	Digital Earth Africa
EO	Earth observation
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
GA	Geoscience Australia
GEO	Group on Earth Observations
GEOGLAM	Group on Earth Observations Global Agricultural Monitoring Initiative
GFOI	Group on Earth Observation's Global Forest Operations Initiative
GMES	Global Monitoring for Environment and Security
GPSDD	Global Partnership for Sustainable Development Data
JAXA	Japan Aerospace Exploration Agency
JER	Japanese Earth Resources satellite
NASA	National Aeronautics and Space Administration (United States)
NDVI	Normalised difference vegetation index
NOAA	National Oceanic and Atmospheric Administration (United States)
ODC	Open Data Cube
OGC	Open Geospatial Consortium
PALSAR	Phased Array-type L-band Synthetic Aperture Radar, an instrument operational on JAXA's ALOS.
PMO	DE Africa's Project Management Office in Africa
S3	Simple Storage Service: Cloud object store used in AWS.
SAR	Synthetic Aperture Radar
SCG	Stakeholder Community Group
SDGs	Sustainable Development Goals
SRTM	NASA's Shuttle Radar Topography Mission
TAC	DE Africa's Technical Advisory Committee
UNECA	United Nations Economic Commission for Africa
USGS	United States Geological Survey
WCS	Web Coverage Service
WEF	World Economic Forum
WMS	Web Map Service
WOfS	Water Observations from Space

II. List of key scientific references describing the basis for the work of the Initiative

A. Lewis, L. Lymburner, M.B.J. Purss, B. Brooke, B. Evans, A. Ip, A.G. Dekker, J.R. Irons, S. Minchin, N. Mueller, S. Oliver, D. Roberts, B. Ryan, M. Thankappan, R. Woodcock, L. Wyborn, "Rapid, high-resolution detection of environmental change over continental scales from satellite data – the Earth Observation Data Cube" *Int. J. Digital Earth*, no 9, pp. 106-111, 2016, 10.1080/17538947.2015.1111952

A. Lewis et al., "The Australian Geoscience Data Cube - Foundations and lessons learned," *Remote Sensing of Environment*, vol. 202, pp. 276-292, 2017.

D. Roberts, N. Mueller and A. McIntyre, "High-Dimensional Pixel Composites From Earth Observation Time Series," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 55, no. 11, pp. 6254-6264, Nov. 2017, doi: 10.1109/TGRS.2017.2723896.

D. Roberts, B. Dunn and N. Mueller, "Open Data Cube Products Using High-Dimensional Statistics of Time Series," *IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium*, Valencia, Spain, 2018, pp. 8647-8650, doi: 10.1109/IGARSS.2018.8518312.

N. Mueller et al., "Water observations from space: Mapping surface water from 25years of Landsat imagery across Australia," *Remote Sensing of Environment*, vol. 174, pp. 341–352, 2016, doi: 10.1016/j.rse.2015.11.003.

M. Halabisky et al. - Validation of the African Water Observations from Space (WoFS) product (in preparation)

III. Brief CV of Project Leader(s)