Operational Services for Africa

This document is submitted to the 18th Plenary for information.

1 INTRODUCTION

Despite accounting for a small proportion of global carbon emissions, African countries are highly vulnerable to the adverse impacts of climate change, including droughts, floods, forest fires, biodiversity loss, water scarcity and food insecurity. These countries must find innovative solutions to these multiple challenges to build resilient economies, secure food, and water systems, and ensure the sustainable management of forest resources and biodiversity.

In an era of big data, Earth observation (EO) technologies and applications offer African countries wealth of data and information that can be used to inform decision making and deal with socioeconomic and environmental challenges. Over the past two decades, Africa has experienced significant growth in space programme development through both collaborative projects and individual efforts at both continental and national levels. Since 1999, a total of 41 satellites have been launched by African states. Rising investment in space infrastructure reflects the growing relevance and application of satellite technology to tackle several socio-economic and environmental challenges confronting the continent.

Africa Union's (AU) Agenda 2063, the continent's blueprint seeks to transform Africa through inclusive and sustainable socio-economic development. Fundamental to Agenda 2063 are the African Outer Space Programme and African Space Policy and Strategy that reinforce the continent's vision to not only be a consumer in the global space arena but to become a producer and regulator of space products. Through these initiatives, the AU is working to address the growing needs of African countries to harness space technologies and services, including Earth observations to drive policies and decisions to attain the agenda 2063 and the Sustainable Development Goals (SDGs).

Earth observation satellites are producing vast datasets on air quality, weather, water resources, land, and vegetation changes, among other variables. Despite the abundance of data, gaps persist in many African countries regarding access to analysis ready EO data, tools, and services. Pilot programmes on EO data generation, technologies and research have been conducted, but on a small scale with limited impact. Digital Earth (DE) Africa, a GEO initiative, provides continental-scale digital infrastructure designed to scale EO products and services in Africa. The programme is enabling African countries to access analysis ready EO data, tools, and services to monitor and track changes in water resource flows, land use change, coastal erosion, illegal mining, mangrove, and forest vegetation.

Within three years, DE Africa has transitioned from a concept to a vibrant programme operating on a continental scale. Drawing on the experience of Digital Earth Australia and sharing goals with Digital Earth Pacific, DE Africa has established itself as a program providing routine, reliable and operational services that are free and open to users across the continent. The DE Africa platform offers free access to 37 years of analysis-ready satellite imagery stored in the Open Data Cube, putting government agencies, research and academic institutions, private entities, and civil society in a better position to tackle a wide range of societal, economic, and environmental challenges. The 540 terabytes of CEOS Analysis Ready Data (CARD), captured by United States Geological Survey (USGS) satellites Landsat 5, 7 and 8 document changes to the landscape of the continent. The data is freely available through Amazon Web Services' S3, it can be analysed in the DE Africa Sandbox and visualised on the DE Africa Map. Additional resources can be found in the Africa GeoPortal, developed by Esri and the notebook repository, which allows users to use, interact and engage with the DE Africa Sandbox.

2 DE AFRICA SERVICES

DE Africa currently offers four main services that provide government, industry and researchers with valuable insights to help address social, environmental and economic change on the continent. These services include:

- Water Observations from Space (WOfS): a continent-wide service that allows anyone to better understand water availability. WOfS uses Landsat 2 Surface Reflection to enable users to understand the location and movement of inland and coastal water across Africa. It shows the presence and absence of water and can be used to assess the change in water extent over time and manage water resources;
- Cropland Extent Map offers a provisional service that currently covers areas in eastern, western, and northern Africa with development of the remaining regions underway. It uses Sentinel 2 surface reflectance to determine the presence or absence of crop at a 10-meter resolution. This information is fundamental to developing more complex agricultural products and empowers governments to inform decisions on food security;
- Fractional Cover describes the landscape classification of ground cover as bare, green, and non-green. This enables analysis of seasonal vegetation, environmental conditions, and agricultural activities. The service uses Landsat 2 Surface Reflection therefore analyses can explore decades of change (back to the 1980s to the current day);
- GeoMAD condenses an entire year's worth of satellite viewing into a single cloud-free, statistically significant composite (Annual GeoMAD). This can be used to inform decisions on crucial sustainability issues such as water resourcing, flooding, coastal erosion, land degradation, food security and urbanisation, and is particularly useful for visualising change over time.

DE Africa data and products are accessible through several open-source visualisations and analysis tools, accessible by users with various levels of technical background (e.g., Analysis Sandbox, DE Africa map, GIS Web Services and ESRI's Africa Geoportal). The free

online training portal is now available in both English and French. As of mid-2020, DE Africa has more than 2000 registered DE Africa sandbox users, over 300 graduates from DE Africa's free, online, bi-lingual training course, over 10,000 unique DE Africa map users, and 2 completed industry incubator studies (Ghana, Kenya) leveraging DE Africa for innovation in agribusiness applications.

3 USER APPLICATIONS ALIGNED TO THE SUSTAINABLE DEVELOPMENT GOAL (SDGS)

To date, DE Africa has documented over 25 cases of DE Africa tools and services supporting the SDGs.

3.1 SDG 2, Zero Hunger

- Creating an open-source framework for crop-type mapping in Zambia. This collaborative work between DE Africa and the Regional Centre for Mapping of Resources for Development (RCMRD) combines the services and tools of Digital Earth Africa with field data to develop a reproducible algorithm for crop type analysis;
- DE Africa is supporting agriBORA platform in East Africa to access and use analysis ready satellite data and services to produce open-source data or software to increase productivity and financial viability in the agricultural value chain.

3.2 SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water)

- DE Africa is providing EO satellite data to monitor water extent in Ghana and rising Lakes in the Rift Valley in Kenya;
- In Lake Ngami, Lower Okavango Delta, Botswana, the DE Africa platform is being used to conduct water assessment and monitoring to address unsustainable agriculture.

3.3 SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities)

- DE Africa platform has been used to monitor the rate of urbanization in Gulu City, Uganda. This will inform decisions on spatial planning and urban service delivery;
- DE Africa satellite data have been processed to detect landscape change and unregulated mining in Ghana.

3.4 SDG 13, Climate Action

- DE Africa platform is providing EO data, tools, and services to support Tanzania in making data-driven decisions on conserving the biodiversity of mangroves in Zanzibar. Through this effort, communities are using data to make decisions to save Zanzibar's mangroves.

4 POTENTIAL ECONOMIC BENEFITS

According to a recent report by the World Economic Forum (WEF), the anticipated socioeconomic benefits of the DE Africa programme could be more than US$2 billion annually by 2024. This includes the contribution to improved agricultural productivity, through water savings, productivity gains, insurance benefits and pesticides reduction, estimated to be US$900 million; data provisions for effective regulation of gold mining activities, saving at least US$900 million from reduced environmental damage and fiscal evasion; and about US$500 million from accelerated growth of the EO industry.

Scaling up operations of the DE Africa programme to deliver market-ready products and services for the entire continent is a complex process. Extensive work has been done to establish a digital infrastructure foundational to this technology-focused programme. Beyond this, a major hurdle cleared has been to work through the complexities embedded within multi-layered societal, institutional, and organizational interactions that create relevance, demand, legitimization, and value for the programme. It could be argued that the successful transition of the DE Africa programme from an idea to an operational service was influenced by multiple factors:

- Building strong engagement and inclusivity of diverse stakeholders has contributed to the co-design and co-development of the DE Africa programme. This offered a better understanding among stakeholders, of the solutions generated and their potential impact to drive policy and inform decisions and strategies. Such engagements identified key institutional partners and local experts and leveraged their experience and expertise to develop a fit for purpose programme that responds directly to the targeted needs and priorities of countries in Africa;
- Fundamental to DE Africa has been the development of a demand-driven programme that matches demand to supply through the development of products and services that address the needs, priorities, and potential use cases for providing EO products and services;
- Consultations with high-level state officials were crucial for political and institutional buy-in. This helped create value and integrate DE Africa into national and regional policy frameworks;
- Involving high-profile national, regional, and global institutions in the governing board and technical advisory committee (TAC) could be viewed as key to strengthening governance and scaling up operations on the entire continent;
    - Senior leaders from institutions including the African Union Commission (AUC), UN Economic Commission for Africa (UNECA), as well as senior government officials from Australia, Ghana, Rwanda and Tanzania, and the GEO Secretariat are on the Governing Board of DE Africa;
    - Technical institutions, such as the Regional Centre for Mapping of Resources for Development (RCMRD), AGRHYMET, South Africa National Space Agency (SANSA), African Regional Institute for Geospatial Information Science and Technology (AFRIGIST), Centre de Suivi Ecologique (CSE) and Ghana National Statistical Office are part of the TAC.

This could be seen as fundamental to the legitimization, ownership, and commitment to the sustainability of the program.

- Developing an interoperable data ecosystem that combines EO data with other data, including socioeconomic data, citizen science data, and statistical data, among others makes DE Africa dynamic and adaptable. This opens the possibility of developing applications and services downstream and creating the space for entrepreneurship and innovative businesses.

5 NEXT STEPS FOR DE AFRICA

Scaling DE Africa operations and service delivery requires the development of a sustainable business model that aims to increase value and socioeconomic benefits. Through continuous stakeholder engagement, needs assessment and the prototype infrastructure, DE Africa has developed a business case to make satellite data operational, available, and freely accessible in Africa. Establishing a Program Management Office and appointing an African leadership team marks a point of growth and ambition to scale up operations across the continent. It also marks a point of transition with a trusted team in Africa to make a tangible impact with innovative products and services tailored to meet the needs of users and address some of the continent's greatest challenges.

The program can build on its current efforts, by among other things strengthening partnerships with AU initiatives such as the African Earth Observation System to scale up Africa's use of EO data and services to attain agenda 2063 and the SDGs. With this innovative digital space created, continental initiatives such as the Global Monitoring for Environment and Security and Africa (GMES & Africa) program can leverage DE Africa operational services to strengthen and build EO capacities in Africa, improve complementarity and limit duplication of effort.

6 REFERENCES

1. Digital Earth Africa (DE Africa) Implementation Plan for GEO Initiative. https://www.earthobservations.org/documents/gwp20_22/DE-AFRICA.pdf
2. Digital Earth Africa https://www.digitalearthafrica.org/media-center/blog
3. Space Generation Advisory Council, Africa Region. Africa - Space Generation Advisory Council
4. World Economic Forum (WEF) 2021. Unlocking the potential of Earth Observation to address Africa's
5. critical challenges in collaboration with Digital Earth Africa. Insight Report. WEF_Digital_Earth_Africa_Unlocking_the_potential_of_Earth_Observation_to_address_Africa_2021.pdf (weforum.org)
6. Agrawal, A. 2021. A Journey Called Digital Earth Africa. Reflections. D4DInsight. https://www.d4dinsights.com/post/reflections-digitalearthafrica