Update on GEO Cloud Computing Programmes

This document is submitted by the Secretariat to the Programme Board for discussion.

1 INTRODUCTION

As part of its ongoing efforts to engage the commercial sector on behalf of GEO Members, the Secretariat has been promoting the use of cloud services for Earth observation data as an important way of extracting information from satellite imagery big data. Cloud services minimize the efforts to download, store, and manage large datasets. In principle, they allow users to focus on the production of information and analysis, rather than focusing on the management of data.

An open call for Earth observation cloud services provision to GEO Members was launched by the Secretariat in September 2019. Offers from commercial providers must abide to the Annex C of the GEO Rules of Procedure, and specifically to the following rules (2.6 and 2.7 from said Annex:

> *"Relations between GEO and commercial sector organizations must be impartial and provide equal access to all commercial sector organizations. GEO engagement with the commercial sector should not provide, nor imply, exclusivity or endorsement or preference to a particular commercial sector organization, product or service; …*
>
> *Services developed by commercial sector organizations as a contribution to the GEO Work Programme should be made freely available, on a best-efforts basis, to GEO Members;"*

In response to the call, three programmes have been launched for competitive proposal submission making use of the cloud computing services offered, with additional support provided by small, medium, and micro-sized enterprises (SMMEs).

2 GEO-AMAZON WEB SERVICES (GEO-AWS) EARTH OBSERVATION CLOUD CREDITS PROGRAMME (INCLUDING SENTINEL HUB SUPPORT FROM SINERGISE)

The GEO-AWS programme, including the use of Sentinel Hub by Sinergise, is nearing completion its first year of implementation[1]. Of the 20 projects that had been approved to receive AWS cloud credits, 11 have been active and are producing preliminary results. The remaining 9 have encountered difficulties (such as legal implications of working with AWS in the lead institution's home country) that have slowed progress. The GEO Secretariat and AWS leadership have been conducting monthly teleconferences to discuss progress and find work-

[1] All projects have up to three years in which to use their allotment of credits. Most projects started in August/September 2019.

around solutions where needed. The Secretariat and AWS are gearing up to contact all projects and determine the number of credits that will be needed starting in July 2020, for the 2nd tranche of the 3-year programme.[2]

Results from one of the more advanced projects, the Brazilian Earth Observation Data Cube using AWS for Land Use and Cover Change (led by the National Institute for Space Research, INPE, of Brazil) include:

1. Forest Monitor: a web-based platform has been implemented to support the detection of deforestation alerts in the Amazon forest in Brazil by accessing and visualizing the remote sensing images stored in the AWS buckets. The system allows the visualization of Sentinel-2A/MSI, Sentinel-2B/MSI, Landsat- 8/OLI and CBERS-4/AWFI image collections from the moment they are published on AWS.
2. Earth observation data cubes for Brazil: multidimensional data cubes have been created from remote sensing images for some regions of Brazil. The scripts use AWS Lambda service accessing images from the Earth observation satellites Landsat, CBERS and Sentinel stored in the Earth on AWS buckets as open data.
3. LUCC classification: scripts have been implemented to extract Land Use and Cover Change (LUCC) information for Brazil from big Earth observation data sets, using satellite image time series analysis, machine learning algorithms and image processing procedures.

A new proposal was submitted by the University of Maryland in April which has recently met with approval from AWS for application of credits.[3] The project proposes to use the GEO implementation of Sen2Agri in the AWS cloud to create several national cropland and crop type maps, in support of the work of the NASA Harvest Consortium and its partner organizations. This project will entail cleaning previously acquired in situ datasets and collecting additional in situ data, creating historical cropland area and crop type maps using the Sen2Agri on AWS software, and evaluating the Sen2Agri on AWS system. Cropland area and crop type maps will also be created using alternative approaches employed by NASA Harvest to provide a baseline of comparison for the Sen2Agri system. This comparison will account for ease of use, cost, and accuracy of both approaches. The workflows identified in this project will leverage our existing cooperation with several nations and through co-development, provide a way forward for future production of EO-derived cropland area and crop type maps in Mali, Kenya, Sudan, Argentina, Ukraine, and the United States.

3 GEO-GOOGLE EARTH ENGINE (GEO-GEE) LICENSE PROGRAMME (INCLUDING TECHNICAL SUPPORT FROM EO DATA SCIENCE)

In response to its call for proposals to make use of unlimited GEE licenses (with technical support from EO Data Science), issued in December 2019 with a closing date of 15 April 2020, the Secretariat received 49 project proposals (for a total of 25 GEE licenses). During the review phase, the intention was to have each proposal reviewed by both the Secretariat and an individual from the GEO community, as well as Google and EO Data Science. Through the

[2] The programme was designed to allocate the credits in three tranches. Unused credits that are allocated but not used are no longer available to the programme. Therefore, to maximize the value of the programme, the Secretariat and AWS seek to understand why credits have not been used before additional credits are allocated.

[3] This opportunity to add another project arose due to some projects being unable to use their credits. This project was accepted because of its close connections with GEOGLAM, the benefits it would provide to multiple countries in Africa, and the need to proceed quickly to avoid loss of the credits.

Programme Board, the Secretariat issued a request for reviewers from the GEO community for help in reviewing the proposals, to which 11 individuals responded (A. Craddock, K. Fontaine, E. Frazier, A. Gutierrez, A. Kabo-bah, S.J.S. Khalsa, B. Killough, S. Marsh, A. Milne, A. Siqueira, F. Van den Bergh). Using a scoring system that evaluates a given proposal in the areas of research excellent, potential impacts, and quality of implementation, the evaluation process will be completed by the end of May. In the case where a revision is requested, the proposal's author will be given 2 weeks to resubmit. Final evaluations will be made at the end of June, and successful applicants announced. The targeted start date for use of the GEE licenses is 1 July 2020.

4 GEO BON – MICROSOFT: EBVS ON THE CLOUD

At the beginning of May 2020, Microsoft's AI for Earth program and GEO BON launched a new USD $1 million grant program to support projects that strengthen efforts to monitor Earth's biodiversity and create Essential Biodiversity Variables (EBVs) and relevant biodiversity change indicators derived from the EBVs. Projects that develop novel approaches to monitoring of biodiversity as well as projects that leverage cloud-scale computation to increase the geographical and temporal coverage of existing monitoring programs will be considered. Each grant recipient will receive up to USD $100k in financial funding, as well as up to USD $100k in Azure cloud computing credits. Support resources through the AI for Earth grants program, including technical advice and online Azure training materials. Applicants must be either individual members or partner organizations of GEO BON. Projects will be selected by a panel of judges identified by the GEO BON Secretariat and Microsoft AI for Earth. Criteria for selection will include:

- Tangible data products and cloud-based workflows and tools that demonstrate the power of Essential Biodiversity Variables to increase the relevance of biodiversity monitoring for policy support and management.
- Potential for project deliverables to scale and be used by other GEO BON members and organizations.
- Degree to which the proposed project leverages Azure capabilities and represents technological innovation.
- Appropriateness of team members' skill sets for completing project.

The grant application deadline is 5 June 2020. Full details can be found on the website here.

5 NEXT STEPS

Projects that have been awarded credits and/or licenses are being tracked by the Secretariat in order to present results at GEO events, such as the GEO Symposium and GEO Week, in order to demonstrate the feasibility of new technological approaches to using Earth observations from a "zero download" approach. This approach will be of particular interest to developing countries as they seek to leverage new analytical tools being made available, using Earth observations with minimal investment and infrastructure outlay. It is anticipated that many of these projects will become integrated as Community Activities of the GEO Work Programme, once they have achieved a degree of maturity.

ANNEX A

LIST OF PROJECTS UNDER THE GEO-AWS EO CLOUD CREDITS PROGRAMME

Project Title	Lead Investigator	Institution	Lead Country	Status	Comments
Brazilian Earth Observation Data Cube using AWS for Land Use and Cover Change	Karine Reis Ferreira	National Institute for Space Research (INPE)	Brazil		Presented initial results during the GEO-AWS EO Cloud Credits side-event during GEO Week 2019.
Filtered Alert Hub Toolset	José Mauro de Rezende	Brazil Meteorological Institute (INMET)	Brazil		
Fire Monitoring Service	Yuqi Bai	Tsinghua University	China		Also working with Sinergise and Sentinel Hub.
A Global Modelling Tool for Nature's Contributions to People in Sustainable Development	Rafael Monge Vargas	Ministry of Environment and Energy	Costa Rica		Presented initial results during the GEO-AWS EO Cloud Credits side-event during GEO Week 2019.
Capacity Building on Monitoring of SDGs	Kofi Asare	Remote Sensing and Climate Centre, Ghana Space Science and Technology Institute	Ghana		Late start due to personnel changes.
Integrating EO Data with Censuses and Sample Surveys to Estimate Development Indicators for India	Krishnachandran Balakrishnan	Indian Institute for Human Settlements	India		Credits awarded but not used. No response to queries.

Project Title	Lead Investigator	Institution	Lead Country	Status	Comments
AWS4AgriSAR-Crop inventory mapping from SAR data on cloud computing platform	Avik Bhattacharya	Centre of Studies in Resources Engineering (CSRE), Indian Institute of Technology	India		
Global Mobile Tsunami Warning System using Amazon Web Sever—A Life-Saving Platform	Gegar Prasetya	Ikatan Ahli Tsunami Indonesia, Tsunami Research Foundation	Indonesia		
Extracting semantic features from for OSM using deep leering and Sentinel 1&2 data for land use classification to support GEO wetland monitoring	Ali Gis	Department of Geography, University of Babylon	Iraq		Also working with Sinergise and Sentinel Hub.
agriBORA - Geodata for actionable farm intelligence	Boniface Akuku	Kenya Agricultural and Livestock Research Organization (KALRO)	Kenya		Also working with Sinergise and Sentinel Hub.
EO for Sustainable Development	Paloma Merodio Gómez	National Institute of Statistics and Geography (INEGI)	Mexico / Colombia		Legal issues for INEGI with respect to establishing account with AWS; trying to work around with Colombia. Presented initial results during GEO-AWS EO Cloud Credits side-event during GEO Week 2019

Project Title	Lead Investigator	Institution	Lead Country	Status	Comments
South Asian drought monitoring and outlook system to support agricultural advisory processes	Basanta Shrestha	ICIMOD	Nepal		Late start due to personnel changes.
Operational monitoring system of ground deformations in Nigeria	Francis I. Okeke	Department of Geoinformatics and Surveying, University of Nigeria	Nigeria		AWS contacted them several times to establish the account, but there was no response.
Spatial Agricultural Intelligence	Joseph OLOUKOI	African Regional Institute for Geospatial Information Science and Technology (AFRIGIST)	Nigeria		AWS account opened and credits awarded but not used. No further communication.
Automation of processes in the cloud, for the generation of mosaics of annual satellite images free of clouds, to contribute in the generation of information on changes in forest cover.	Rolando Eduardo Vivanco Vicencio	National Program for the Conservation of Forests for the Mitigation of Climate Change of the Ministry of the Environment of Peru	Peru		Using Sentinel Hub. They are not using the AWS credits because they do not want to overrun the account.
Air Quality Forecasting for Africa	R Subramanian	Kigali Collaborative Research Center (KCRC)	Rwanda		Late start due to personnel changes.

Project Title	Lead Investigator	Institution	Lead Country	Status	Comments
AfriCultuReS Decision Support System (ADSS) Community Version	Nosiseko Mashiyi	South African National Space Agency	South Africa		
Methodology for SDGs indicators assessment	Nataliia Kussul	Space Research Institute NAS Ukraine and SSA Ukraine	Ukraine		Presented initial results during the GEO-AWS EO Cloud Credits side-event during GEO Week 2019.
Deep Learning for Satellite Monitoring of Illegal Amber Mining in Ukraine	Oleg Seliverstov	Kharkiv National University	Ukraine		Also working with Sinergise and Sentinel Hub.
Monitoring Rice Paddy and Flood in the Lower Mekong Basin	Pham Bach Viet	HCMC Space Technology Application Center	Vietnam		AWS account opened and credits awarded but not used. No further communication.

ANNEX B

LIST OF PROPOSALS UNDER THE GEO-GEE LICENSE PROGRAMME

Project name	Lead Investigator	Contact	Country
Remap	Nicholas Murray	College of Science and Engineering, James Cook University	Australia
Paddy Watch	Budiman Minasny	Sydney Institute of Agriculture, University of Sydney	Australia
Forest Inventory - Nepal	Shiva Khanal	University of Western Sydney	Australia
Alert System for Algal Bloom	Felipe de Lucia Lobo	Federal University of Pelotas (UFPel)	Brazil
Night-time Light mapping	Qingling Zhang	Sun Yat-Sen University	China
Geological Hazards	Lizhe Wang	School of Computer Science, China University of Geosciences	China
LDN	Yuran Cui and Xiaosong Li	Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences	China
AI methods for land change detection	Johoner Venicio Correa Cruz	Autoridad Nacional de Licencias Ambientales (ANLA)	Colombia
Coastal erosion and mangrove ecosystems	Julián José Pizarro Pertúz	Institute of Marine and Coastal Research (INVEMAR)	Colombia
Multi-temporal change detection	Sandra Milena Ortegón	Administración de la información geodésica, cartográfica y geográfica	Colombia
Land cover information	Jaime Lopez	Universidad del Tolima	Colombia

Project name	Lead Investigator	Contact	Country
Deforestation / forest degradation	Rafael Monge	National Center for Geoenvironmental Information (CENIGA) of the Ministry of Environment and Energy (MINAE)	Costa Rica
Identification of vulnerable areas and / or climatic risks	Carlos Noboa	Ministerio del Ambiente (Ecuadorian Ministry of Environment)	Ecuador
Urban agricultural intensity with SAR and optical RS	Wegayehu Asfaw	Faculty of Hydraulic and Water Resources Engineering, Institute of Water Technology, Arba Minch University	Ethiopia
ARD for water security	Carrol Chan Nicholas Metherall	Pacific Community (SPC), Australian National University (ANU)	Fiji
Coastal ecosystems	Dimosthenis Traganos	German Aerospace Center (DLR)	Germany
Cocoa production	Edward Amankwah	Center for Environmental Governance (CEGO)	Ghana
Urban nature-based solutions	David Parastatidis	Remote Sensing Lab, Foundation for Research and Technology Hellas	Greece
Multi-hazard framework	Angelos Amditis	Institute of Communication & Computer Systems (ICCS)	Greece
Wildfire management	Muhammad Pramulya	Tanjungpura University	Indonesia
Marine Coastal Eutrophication	Joji ISHIZAKA	Institute for Space-Earth Environmental Research, Nagoya University	Japan

Project name	Lead Investigator	Contact	Country
Carbon footprint - Mombassa	Majambo Gamoyo	Coastal & Marine Resource Development (COMRED)	Kenya
Natural resources management	Charles Mwangi	Kenya Space Agency	Kenya
Flood monitoring	Rakotondraompiana Solofo	Institute and Observatory of Geophysics, University of Antananarivo	Madagascar
Vulnerable Settlements	Elio Atenó_x0013_genes Villaseñor García	National Institute of Statistics and Geography (INEGI, Mexico)	Mexico
Ice shelf monitoring	Stef Lhermitte	Department of Geoscience & Remote Sensing, Delft University of Technology	Netherlands
Re-/de-/afforestation monitoring	Rogier Westerhoff	GNS Science	New Zealand
i) Multi-scale Flood Monitoring and Assessment Services for West Africa (MiFMASS) ii) UK Space Agency – International Partnership Programme: Strengthening Public Policy from Space (SPPS): Satellite-enabled Data Services	Ganiyu Ishola Agbaje	African Regional Centre for Space Science & Technology Education-English (ARCSSTE-E)	Nigeria
Forest carbon	John Agbo Ogbodo	Department of Forestry and Wildlife, Nnamdi Azikiwe University Awkam	Nigeria
Urban slum monitoring	Mansir Aminu	National Space Research and Development Agency	Nigeria

Project name	Lead Investigator	Contact	Country
Fire danger warning system	Piotr Zaborowski	Eversis sp. z o. o.	Poland
Improved agricultural productivity	Gayane FAYE,	Laboratoire de Télédétection Appliquée (LTA)	Senegal
Mapping small-scale maize farms	J.G Chirima	Geoinformation Science Division, Agricultural Research Council (ARC), Institute for Soil, Climate & Water	South Africa
Vegetation monitoring - Cape Floristic Region	Glenn Moncrieff	South African Environmental Observation Network (SAEON)	South Africa
Environmental degradation monitoring	James Takawira Magidi	Geomatics Department, Tshwane University of Technology	South Africa
Global environmental change monitoring	Yifang Ban	Division of Geoinformatics, Department of Urban Planning & Environment KTH Royal Institute of Technology	Sweden
Multidimensional poverty data - Africa	Adel Daoud	Department of Sociology and Work Science, University of Gothenburg Center for Population and Development Studies, Harvard University	Sweden / United States
Farm insurance for natural disasters	Gautam Dadhich	Asian Institute of Technology	Thailand
Sustainable water management	Mustapha MIMOUNI	Observatoire du Sahara et du Sahel (OSS)	Tunisia

Project name	Lead Investigator	Contact	Country
Scottish wildfire and muirburn mapping and monitoring system	Philippa Vigano Duncan Blake	Scottish Natural Heritage (NatureScot)	United Kingdom
Deep learning methods for land cover and land use classification	Nataliia Kussul	Space Research Institute NAS Ukraine and SSA Ukraine	Ukraine
Environment and climate stress index	David Jensen	Crisis Management Branch, UN Environment	UNEP
Monitoring Disasters Impacts on Land Cover in Coastal Zones of Egypt	Wafa Aboul Hosn	Statistics Division, UN House,	UNESCWA
AquaWatch	Steven Greb	Space Science and Engineering, University of Wisconsin-Madison	United States
Disaster forecasting, mitigation, response	Charles K. Huyck	ImageCat, Inc	United States
Ecological Integrity Index	Ivan Orlando González Garzón	Northern Arizona University	United States
Regenerative agriculture	Daniel Swid	Regen Network Development, Inc.	United States
trends.earth - supporting LDN	Mariano Gonzalez-Roglich	Moore Center for Science, Conservation International	United States
EBV-ScaleUp	Robert Guralnick (UFL) Carsten Meyer (iDiv)	University of Florida and Florida Museum of Natural History German Centre for Integrative Biodiversity Research (iDiv)	United States / Germany