

GEO Global Agricultural Monitoring Flagship Initiative (GEOGLAM)
Implementation Plan for the GEO Work Programme 2020-2022
Contact: Ian Jarvis, Programme Director (ijarvis@geosec.org)

1. Executive Summary

The Group on Earth Observations Global Agricultural Monitoring Initiative (GEOGLAM) was initially launched by the Group of Twenty (G20) Agriculture Ministers in Paris, June 2011 during the French G20 Presidency. The GEOGLAM Initiative forms part of the G20 Action Plan on Food Price Volatility. GEOGLAM is a Group on Earth Observations (GEO) Flagship Initiative. The purpose of GEOGLAM is to increase market transparency and improve food security by producing and disseminating relevant, timely, and actionable information on agricultural conditions and outlooks of production at national, regional, and global scales. It achieves this by strengthening the international community's capacity to utilize coordinated, comprehensive, and sustained Earth observations.

GEOGLAM participants include representatives from most G20 nations, many additional countries including from food insecure regions, several international organizations and NGOs. The GEOGLAM Crop Monitor for the Agricultural Monitoring Information System (AMIS) encompasses over 80% of global production, consumption and trade volumes of targeted crops (maize, rice, wheat and soybean), and has over 40 contributing institutions feeding in information on a monthly basis. The Crop Monitor for Early Warning (CM4EW) monitors crops that are important in countries and regions that are susceptible to food insecurity. Over a dozen international food security organizations feed in to the monthly monitors and also benefit from the published results. In 2019 GEOGLAM, at the request of the United Nations Office for Coordination of Humanitarian Affairs developed the capability to produce mid-month reports in areas of emerging concern.

Both Crop Monitor publications are internationally recognized as a reliable source of information on global crop conditions and are used by a range of ministries and multi-national and international organizations to inform decisions. In recent years the early warning focus has moved to engaging national organizations. These monitors are run by mandated agencies within nations to support policy and program decisionmakers, and have resulted in rapid deployment of proactive policies and programs to mitigate disasters and mobilization of resources in response to emerging food emergencies.

Any operational system must be underpinned by a strong R&D capacity. The operational R&D foundation of GEOGLAM is the Joint Experiments for Crop Assessment and Monitoring (JECAM). Currently the JECAM network is focused on R&D towards the development of operational crop type, area, and condition analysis. Within projects funded by G20 nations, JECAM conducts method inter-comparison research on a network of data-rich test sites around the world. Its goal is to reach a convergence of analytical approaches, developing monitoring and reporting protocols and best practices for a variety of global agricultural systems.

Currently, capacity development is spread across several GEOGLAM activities. By mid-2019, a Thematic Coordination Team on Capacity Development (CapDev Team) will be developed to better coordinate and harmonize activities across the contributing initiatives. The CapDev Team will have the role of promoting a community research and operationalization agenda, developing a strategic

vision for capacity development for GEOGLAM, documenting and promoting good practices around capacity development, coordinating the transfer of research-to-operations, and working with scientific leads.

The policy context of GEOGLAM has evolved since its inception. GEOGLAM is embracing the opportunity to support the GEO priorities of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals; Paris Accord and the Sendai Framework. GEOGLAM currently principally produces and publishes crop condition assessments using qualitative descriptors. These are a direct response to AMIS', the Early Warning community's, and other stakeholder needs, but GEOGLAM realizes these new policy challenges require an evolution towards more quantitative metrics. In response the community is defining a set of Essential Agricultural Variables (EAVs) for GEOGLAM.

GEOGLAM embraces the GEOSS Data Sharing Principles and has greatly benefited from open data sharing. The community operationally produces information products from this data and our work would not be possible without open data access. In turn our community makes its information products openly available to all. Indeed the open and transparent approach to information development and dissemination is what allows GEOGLAM to be a trusted and authoritative source of information. In the current state (2019) some partners produce data, GEOGLAM does not. However, as we develop our essential variables we anticipate we may produce data in the future, and this too will be made openly available in line with GEO data sharing principles.

The vast majority of GEOGLAM resources come from in-direct and in-kind funding of activities that contribute to GEOGLAM outcomes. This includes support for R&D as well as operational implementation. This type of funding amounts to millions of dollars annually (Table B). On the other hand direct funding needs for the GEOGLAM Secretariat to support coordination and communication are relatively small, but the role this plays is critical. Current 2019 direct funding levels are approximately \$400k. As of this implementation plan these funds will terminate by the end of calendar year 2019. In light of the serious resource risk, GEOGLAM is working to develop a business case to support sustainable resource mobilization for GEOGLAM through the 2020-2022 work programme timeframe.

2. Purpose

The Group on Earth Observations Global Agricultural Monitoring Initiative (GEOGLAM) was initially launched by the Group of Twenty (G20) Agriculture Ministers in Paris, June 2011 during the French G20 Presidency. The GEOGLAM Initiative forms part of the G20 Action Plan on Food Price Volatility. GEOGLAM is a Group on Earth Observations (GEO) Flagship Initiative.

The purpose of GEOGLAM is to increase market transparency and improve food security by producing and distributing relevant, timely, and actionable information on agricultural conditions and outlooks of production at national, regional, and global scales. It achieves this by strengthening the international community's capacity to utilize coordinated, comprehensive, and sustained Earth observations. Simply put, EO can help to provide better, more objective and synoptic information on crop production, and better information allows for better decision making at all levels, from the farmer to global commodity markets, and national to international policy and programs.

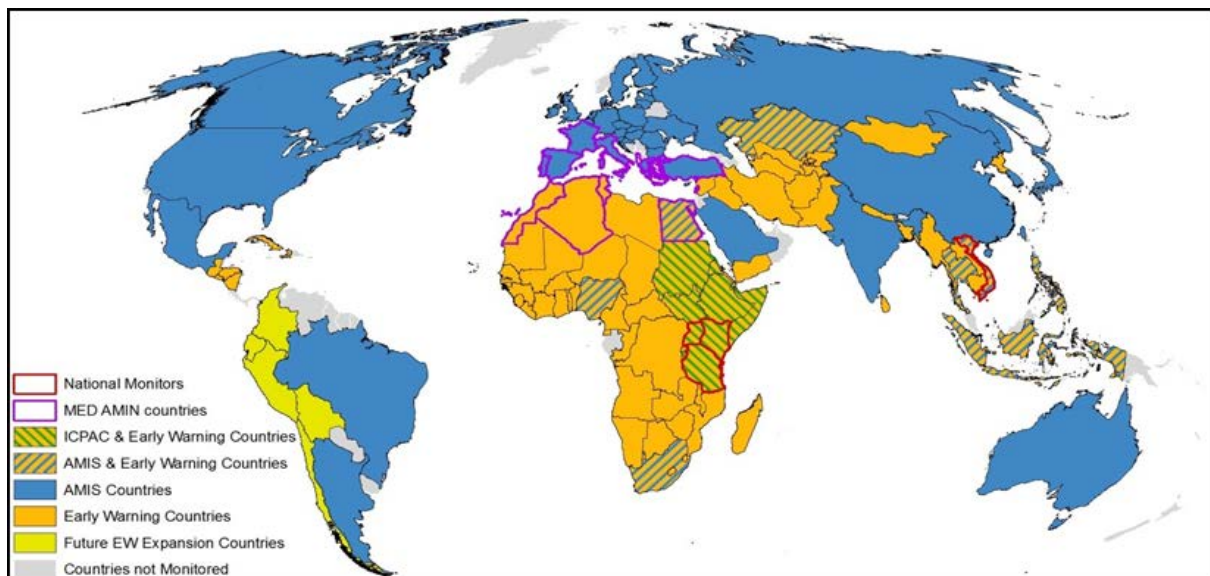
GEOGLAM outcomes leverage existing systems where possible, and where systems do not exist, capacity is developed to utilize Earth observations. In doing so GEOGLAM harmonizes existing global, regional and national monitoring systems while strengthening national systems within the main producer countries and in countries-at-risk of food insecurity. Current outcomes are largely based on top down global to national scale assessments. Over time, as national systems are developed and strengthened the approach will result in more bottom up, national to global information flow. GEOGLAM has found that the greatest impact can be obtained when national mandated agencies develop their own information and convey this directly to policy and programs that support rapid proactive response to food security challenges. Ultimately better national level information will improve the global scale information GEOGLAM provides.

GEOGLAM was built upon a strong foundation of research and development with a focus to developing operational tools and monitoring systems. GEOGLAM provides a forum for the global agricultural monitoring community to collaborate, and enables countries to actively participate, share experiences and keep abreast of new developments. Central to this approach has been the implementation of a global R&D network, the Joint Experiments for Crop Assessment and Monitoring (JECAM).

GEOGLAM participants include representatives from most G20 nations, many additional countries, several international organizations and NGOs. GEOGLAM information covers all G20 nations, as well as other major importing and exporting countries. The GEOGLAM Crop Monitor encompasses over 80% of global production, consumption and trade volumes of AMIS targeted crops (maize, rice, wheat and soybean).

The Crop Monitor for Early Warning (CM4EW) monitors crops that are regionally important for food security, generally encompassing countries and regions that are susceptible to food insecurity. Combined, the GEOGLAM Crop Monitors cover the majority of the world (Figure 1).

Figure 1. Global Coverage of GEOGLAM Crop Monitors

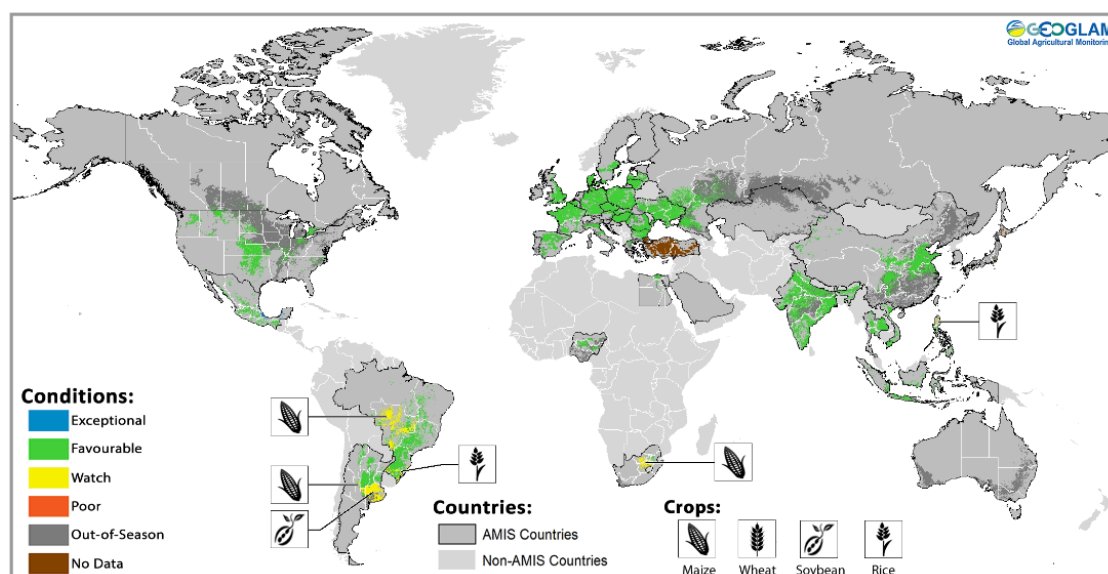


3. Background and Previous Achievements

In response to the 2011 G20 Action Plan on Food Price Volatility and Agriculture, GEOGLAM and the Agricultural Market Information System (AMIS) quickly established a strong partnership. Responding to a direct request from AMIS, GEOGLAM's contribution to market information is an international consensus report based on Earth observation data and expert input from a network of over 40 participants including national assessments and global analysis by China's CropWatch; United States Department of Agriculture's Crop Explorer; and the European Commission's (JRC) MARS system, and more recently the JRC Anomaly Hotspots of Agricultural Production (ASAP) application.

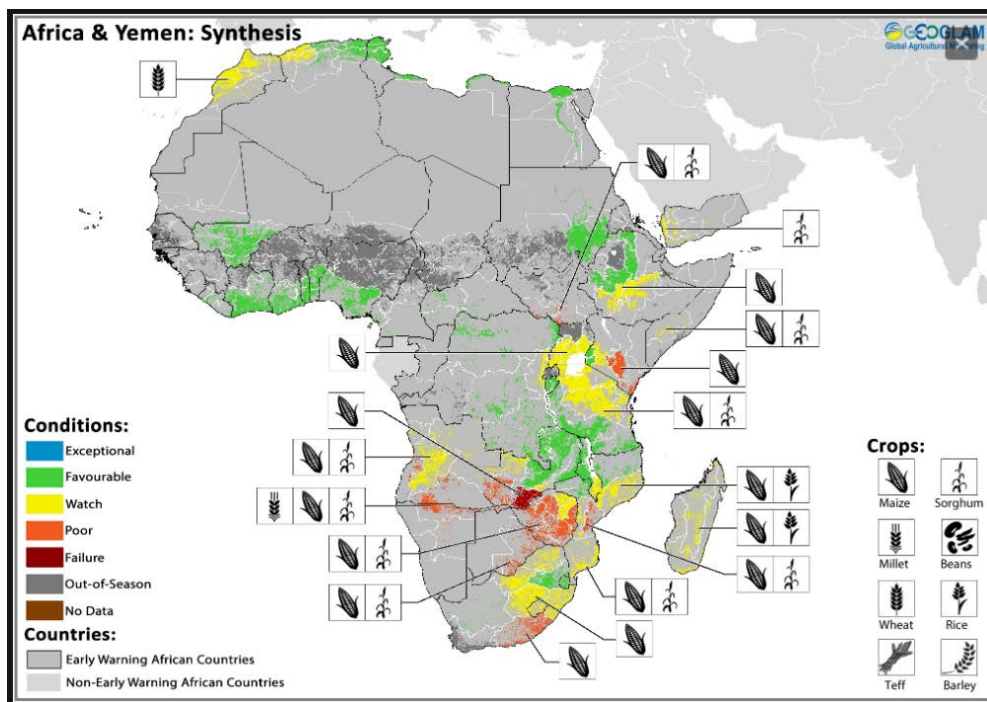
The Crop Monitor for AMIS is published monthly for the 4 major AMIS crops (wheat, maize, soybean, and rice) for the AMIS producer countries responsible for over 80% of global production. Since September 2013, over 60 monthly GEOGLAM CM4AMIS bulletins have been generated for inclusion in the AMIS Market Monitor (<http://www.amis-outlook.org/>). March 2019 overview is provided in Figure 2.

Figure 2 Crop Monitor Overview for AMIS, March 2019



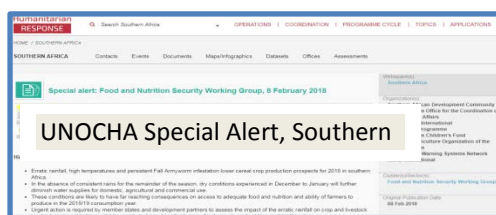
In 2016, building on the success of the CM4AMIS, GEOGLAM partnered with many of the major global food security organizations to develop a Crop Monitor for countries at risk of food insecurity (figure 3). In contrast to the CM4AMIS, the Crop Monitor for Early Warning (CM4EW) focuses on a range of 14 crops that have regional food security implications. Over 35 monthly CM4EWs have been published since 2016 (<https://cropmonitor.org/>).

Figure 3 CM4EW for Africa, April 2019



The CM4EW reports are used by food security organizations, including the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). In 2018 the OCHA referenced the CM4EW in a food security alert for Southern Africa. In the alert they also indicated a need for more frequent information in areas of emerging concern. Based on this requirement GEOGLAM responded, and in March 2019 released a special interim report in response to the South African drought, and the early impact assessment from cyclone Idai .

Figure 4 Development of Special Reports for Emerging Food Security Hot Spots



UNOCHA Food Security Special Alert and Recommendations
February 8, 2018

Urgent Actions:
"There is urgent need for members states and development partners to determine the scale and extent of the possible impact of the prolonged dry spell on the agricultural season (crop and livestock) to inform appropriate response actions for food security and nutrition and build the resilience of vulnerable populations in the region. **Recommended actions include increased monitoring of the situation**, ascertaining available cereal stocks, **fast-tracking of planned crop assessments and annual vulnerability assessments** for early warning and early action and increasing off season production where possible."



Responding to Recommendations
GEOGLAM Implements the Capability for Bi-Monthly Reporting in Hot Spots
March 19, 2019

Both global GEOGLAM Crop Monitor publications are internationally recognized as a reliable source of information on global crop conditions, and are used by a range of ministries, multi-national, governmental, and non-governmental organizations to inform agricultural decisions.

In recent years, the early warning focus has moved to engaging national organizations in the development of national instances of the Crop Monitor bulletins. These monitors are run by mandated agencies within nations to support policy and program decision-makers and have resulted in rapid deployment of proactive policies and programs to mitigate disasters and mobilization of resources in response to emerging food emergencies.

Any operational system, particularly one based on a quickly evolving technology like Earth observation, must be underpinned by strong R&D. The operational R&D foundation of GEOGLAM is the Joint Experiments for Crop Assessment and Monitoring (JECAM <http://jecam.org/>). The JECAM network is focused on R&D towards the development of operational crop type, area, and condition analysis. Within projects funded by G20 nations, JECAM conducts method inter-comparison research on a network of more than 40 data-rich test sites around the world (figure 5). Its goal is to reach a convergence of analytical approaches, developing monitoring and reporting protocols and best practices for a variety of global agricultural systems. Past cross-site experiments have resulted in the development of tools to utilize free and open data from Europe’s Sentinel satellite constellations and USGS/NASA Landsat data. More recent cross-site experiments include the use of synthetic aperture radar (SAR) data for crop type mapping and biomass estimation in cooperation with AsiaRICE crop team.

Figure 5 JECAM Site Status, April 2019



Developing a system of systems for global agricultural monitoring requires highly coordinated and sustained access to Earth observation data. In the time since GEOGLAM’s 2011 inception, we have moved from an era of EO data scarcity to one in which the major constraint is our community’s ability to utilize the vast resource of freely available data. Consequently, from the outset GEOGLAM

established a partnership with public space agencies through the Committee on Earth Observation Satellites (CEOS). GEOGLAM provides the international public space agencies with a GEOGLAM community consensus on the observation requirements for agricultural monitoring. The initial requirements, first established in 2012, include spatial, temporal, and spectral requirements for the variety of cropping systems found around the world. In 2018 the requirements were updated to also include the “data to decisions” continuum, including acquisition coverage, user capacity, and the technology infrastructure needs to fully utilize open EO data.

Significant progress has been made in GEOGLAM over the 2017-19 work plan timeframe. Some of the major contributions are listed as follows:

Activity: Crop Monitor for the Agricultural Market Information System	
Complete and continuing	Published monthly reports of near real time global crop conditions in G20 and other major producing nations. (www.amis-outlook.org/amis-monitoring/crop-monitor/overview/en/)
Activity: Crop Monitor for Early Warning (CM4EW)	
Complete and continuing	Published monthly crop condition reports for food insecure nations of the world. (https://cropmonitor.org/)
Activity: Capacity Development - National and Regional Crop Monitoring (Implemented and operated by mandated agencies, supported by GEOGLAM)	
Complete and continuing	Implementation of National Crop Monitors: Uganda; Kenya; Tanzania; Vietnam. Development of Regional Crop Monitors: Horn of Africa (10 nations). Training of quantitative yield forecasting with several tools including the Crop Statistics Tool (JRC). Operational in Algeria, still in testing for: Senegal, Burkina, Ethiopia, Somalia, South Africa. Implementation and customization of CropWatch Cloud: Mozambique. Development of customized CropWatch Cloud: Egypt, Mongolia, Russia, and Lower Mekong Basin (5 countries). Implementation of rice crop outlook using Japan’s agromet information system (JASMIN) in ASEAN member states using Japan ASEAN trust fund as new ASEAN project during 2019-2020 proposed by LAPAN and MOA, Indonesia. (https://suzaku.eorc.jaxa.jp/JASMIN/index.html)
Activity: Participatory CropWatch Cloud Platform	
Complete and continuing	CropWatch migrated to a cloud service platform including CropWatch Processing, Explore, Analysis, and Bulletin sub systems. Providing service to the public through quarterly bulletins and monthly updates. Partners can have access to agro-climatic, agronomic, and PAY information, and make use of CropWatch analytics to independently analyze crop conditions for a region of interest. (https://cloud.cropwatch.com/cn/)
Activity: Review of Data and Systems Requirements for Operational Agricultural Monitoring	
Complete	Workshop held. (http://www.grainwatch.cn/geoglam/index.html)

Activity: Study on the Value of Earth Observations and GEOGLAM to Commodity Markets

On track and continuing	Progress on track, preliminary results presented to the AMIS Rapid Response Forum, 26 February 2019
-------------------------	---

Activity: Increased Emphasis on Regional Networks

On track	New GEOGLAM networks established in Asia+ (Belt and Road) and Agricultural Monitoring in the Americas; strengthening of Asia-RICE with ASEAN project (AFSIS) as well as Mekong Basin rice monitoring initiative with CEOS2019 priority and ESA GEORice project and expand to South Asia in cooperation with South Asia countries under Asia Pacific Regional Space Agency Forum (APRSAF) Space Application for Environment (SAFE) project.
----------	--

Activity: ASAP – Anomaly Hotspots of Agricultural Production

Complete and continuing	Online decision support system for early warning of agricultural production anomalies (crop and rangeland), developed by the JRC for food security crises prevention and response. Monthly assessments for hotspot countries published on the ASAP platform, a direct JRC contribution to the CM4EW. (https://mars.jrc.ec.europa.eu/asap/)
-------------------------	--

Activity: MARS – Neighborhood Bulletins

Complete and continuing	The JRC MARS crop monitoring bulletins have been complemented by a series of neighborhood bulletins that are now published twice a year. Countries covered are North Africa, Ukraine, Turkey, Russia and Kazakhstan (https://ec.europa.eu/jrc/en/mars/bulletins)
-------------------------	---

Activity: “Essential Agricultural Variables” (EAVs) for GEOGLAM

New activity initiated	White paper written to support development of EAVs, towards the development of quantitative metrics to support markets and food security, and new policy drivers around the UN Sustainable Development Goals; Paris Accord and the Sendai Framework for Disaster Risk Reduction.
------------------------	--

Activity: Development of a Forward Community Research Agenda for GEOGLAM

New activity continuing	First draft completed.
-------------------------	------------------------

Activity: RaPP – Rangeland and Pasture Productivity

Complete and continuing	Extension of GEOGLAM goals into the rangeland and pasture systems sustaining livestock production. Aims at enhancing the community of practice of EO in rangelands.
-------------------------	---

Activity: RaPP Map – Rangeland and Pasture Productivity Map	
Complete and continuing	Online tool for monitoring rangeland and pasture condition. Developed by CSIRO initially for the Australian rangelands, it has been expanded to have global coverage. https://map.geo-rapp.org/

Activity: GEOGLAM Observation Requirements	
Complete	An articulation of spectral, spatial, and temporal resolution requirements for satellite-based observations to create Essential Agricultural Variables and Core Information Products for GEOGLAM. Results presented to CEOS, who are now preparing their strategic response.

GEOGLAM as a GEO flagship represents the very best example of how the convening power of GEO was able to bring a community together to operationally deliver EO based services that are making a difference for commodity market stability and food security and early warning. GEOGLAM is a program and as such, with sufficient support, the community intends to continue delivering timely accurate and relevant information to support food commodity markets and early warning for food security.

4. Relationship to GEO Engagement Priorities

The original GEOGLAM policy mandate from the G20 Agriculture Ministers had a specific focus on better information to support commodity markets. Both GEOGLAM and AMIS have been consistently re-endorsed by the Agriculture Ministers since 2011. The information requirements from AMIS are evolving, and there is a need for independent EO based quantitative metrics on production (i.e. yield and area) throughout the growing season. Further, there is a desire for a better understanding of what is happening beyond the single growing season and to understand the impacts of climate variability and climate change on the state, change, and forecasts in agricultural production (e.g. crop type, extent and yield) and the implications of these changes on sustainability.

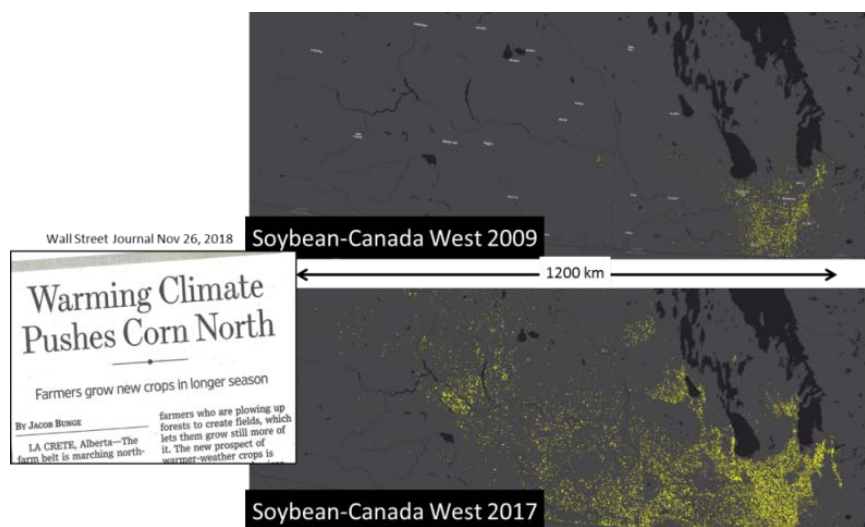
Beyond AMIS, in the 8 years since GEOGLAM started, the G20 policy landscape has also evolved. It now encompasses a strong focus on food security and a growing recognition of the need to do more with respect to the SDGs, food security, resilience, and climate change. It is not merely coincidental that these needs are broadly reflected in the GEO engagement priorities.

In response to the evolving policy landscape, the GEOGLAM community understands that they have a lot to offer and indeed are already contributing in a number of areas. Current GEOGLAM metrics, while grounded in science-based information, are largely qualitative. These meet current needs, but GEOGLAM realizes these new policy challenges require an evolution towards more quantitative metrics. In response the community is defining a set of Essential Agricultural Variables (EAVs) for GEOGLAM, which builds on and complements both existing GEOGLAM activities (including the development of observation requirements with the CEOS agencies, our research & development agenda, the reinvigoration of the CapDev Team, and engagement with the 2030 Agenda on Sustainable Development) as well as Essential Variables from other communities such as biodiversity and climate.

Effective delivery on the engagement priorities will require unprecedented integration across science domains. To move forward, we recognize that GEOGLAM must be able to engage other science communities and the custodian agencies at the national and global levels. GEOGLAM will use the EAVs to enhance communication across science domains, drive our R&D priorities, and define our data and infrastructure needs going forward. The EAV activity will be a major contribution from GEOGLAM to the 2020-2022 GEO Work Programme. The following provides a few examples of how GEOGLAM can, and in some cases already is, delivering on the GEO priorities:

- **Example 1: Sustainable development Goals, Target 2.c, Food Price Volatility.** Since 2013 GEOGLAM has delivered information to AMIS, helping to limit extreme food price volatility, directly contributing to Target 2.c by helping to stabilize food commodity markets through timely reliable Earth observations (Figure 2).
- **Example 2. Sendai Disaster Risk Reduction, Near Real Time Crop Conditions.** Timely, accurate, and actionable information that satellites provide empowers proactive rather than reactive response to loss and damage, saving millions of dollars while improving the quality of life. For example, in 2017 the Office of the Prime Minister Uganda was able to use satellite data to detect and forecast drought and initiate a proactive risk reduction and response plan three months earlier than they previously had. This early warning allowed them to put in place mitigation programs to offset losses improving the outcome for 150,000 people while saving an estimated 2.6M USD compared to what emergency food response would have cost. In another example, the Argentine Ministry of Agroindustry relied on both satellite data and the capacity of the GEOGLAM network (principally INTA-Argentina) to produce a precise and robust mapping of areas impacted by Argentina’s major drought in early 2018. With this information, the MinAgro was able to delay tax payments for farmers, an important disaster relief mechanism. .
- **Example 3: Paris Climate Accord, Understanding the Impact of Climate Change on Agricultural Landscapes.** Crop mapping provides quantifiable insights into how the agricultural landscape is adapting to climate change. The example from Canada provides insight into how climate change is being expressed in changes to crop production, Figure 6.

Figure 6. Changes in Crop Production, Soybean Western Canada



5. Stakeholder Engagement and Capacity Development

Capacity development has been a key activity within GEOGLAM since its inception, with improved decision-making drawing on EO in many parts of the world. GEOGLAM has fully embraced the ideas of co-development and we have had great successes in its application. We have found the greatest impact on human well-being comes when nations are enabled to create their own information within mandated agencies close to the programs and policy actors that can make use of it. The net result is trusted information that can quickly be turned into decisions. Our success is such that the demand for GEOGLAM co-development support is approaching our collective capacity to deliver. To effectively respond to this challenge we are working to enhance coordination between activities so that best practices can be developed and shared amongst the community. Our strategy to achieve this will be developed over the 2019-2020 timeframe and reported on in an update to this work plan.

Capacity development is spread across several GEOGLAM activities and we are in the progress of enhancing coordination by the establishment of a Thematic Coordination Team on CapDev (CapDev Team) to better coordinate and harmonize capacity development across initiatives. The CapDev Team will be established by mid-2019 with members who are active in capacity development and stakeholder engagement. The CapDev Team will have the role of promoting a community research and operationalization agenda, developing a strategic vision for capacity development for GEOGLAM, documenting and promoting best practices around capacity development and coordinating the research-to-operations cycle (with the R&D scientific leads and teams).

There are five main activities that the working group will support with the overarching goal of building individual, organizational, and institutional capacity to use GEOGLAM outputs. Tentative Activities [pending formation of the working group and consensus approval]:

1. Leveraging what GEOGLAM members are doing in capacity development in their contributing activities by identifying examples of good capacity development practice by GEOGLAM members and by working with GEOGLAM members to document the processes of developing and implementing those good practices.
2. Promote good capacity development practices by developing and disseminating guidance documents and by increasing awareness of capacity development good practices.
3. Recommending ways to accelerate implementation in additional countries and regions by supporting members in the development of theory of change (ToC) models and by recommending the most appropriate ToC and good practices for additional countries.
4. Recommending selection criteria to identify and characterize countries for future capacity development interventions.
5. Identifying opportunities for training workshops, knowledge transfer, and resource and experience sharing with capacity development networks (e.g. CEOS WGCapD, AfriGEOSS, AmeriGEOSS, AOGEOSS, SERVIR, AfriCAB, MESA, FAO, START, APRSAF and AFSIS) as well as with Regional Network Coordinators and sharing these with co-chairs and relevant networks.

Key tentative outputs include the development of a guidance document - for endorsement at GEOGLAM and/or CEOS level – on good practices for designing and implementing capacity development relationships at individual, organizational and/or institutional levels. This document will also include narratives from GEOGLAM members and stakeholders on examples of successful engagement. The guidance document will cover:

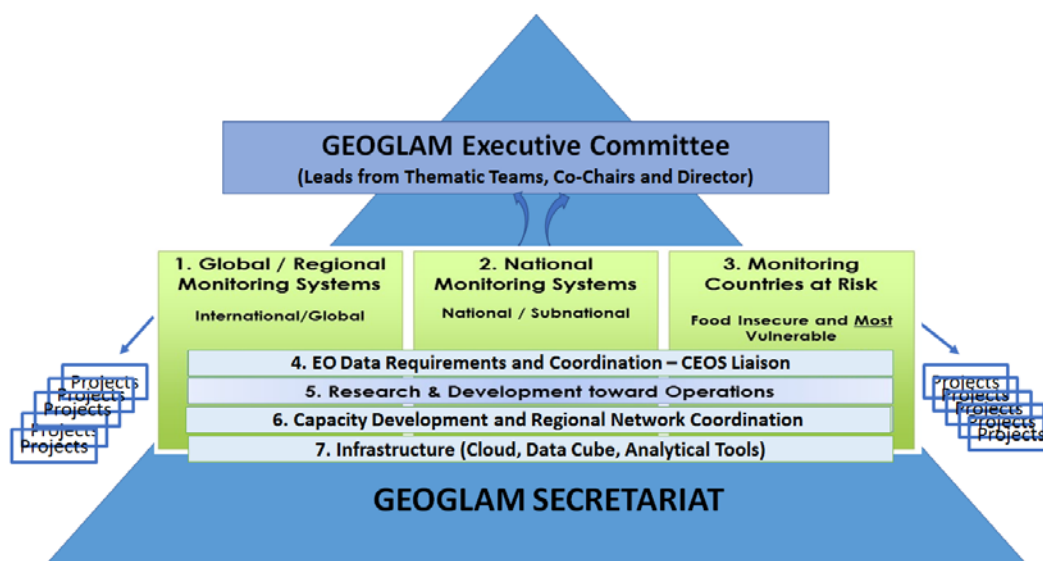
1. When and how to identify and engage with stakeholders;
2. Identifying the scope of the capacity development activities by carrying out a user needs assessment, with examples of what a user needs assessment looks like;
3. How to develop and deploy training materials that consider the audience;
4. The options for longer-term stewardship and maintenance of the training materials;
5. Approaches to achieve co-design / co-production, with examples of the benefits of co-design / co-production;
6. Performing evaluations to assess what is/is not working throughout the capacity development relationship;
7. The order of operations and timelines for carrying out each of the above activities in different multinational and collaborative settings.

Another output will be a framework for identifying and characterizing countries/end users for capacity development interventions. This will require the identification of ranking and selection criteria, although the application of criteria will be flexible to empower bottom-up, activity-led action.

6. Governance

From the early days of its inception as a GEO Community of Practice within the Agriculture Societal Benefit Area, GEOGLAM has had an informal and *ad hoc* approach to governance. The approach was based on common interest and best efforts of its participants. This approach was effective and served the community well for several years. However, as GEOGLAM matured it became clear that stronger governance would be required to develop a sustained effort while addressing evolving policy drivers, while meeting the governance expectations of potential funding organizations. To rise to the existing and evolving challenges, governance was strengthened in 2018 with the adoption of a somewhat more formal structure (Figure 7). Following on from the new GEOGLAM governance model, in 2018 GEOGLAM created an Executive Committee and has established technical and regional working groups to address needs as required and as resources permit. Overall activities, or “glue functions,” are coordinated and maintained by the GEOGLAM Secretariat.

Figure 7. GEOGLAM Governance



Key roles in GEOGLAM governance are identified below (from 2017 governance white paper):

The GEOGLAM Secretariat. The GEOGLAM Secretariat, administered by the Program Director is the program coordinating body of GEOGLAM, composed of individuals who represent formal, direct contributions to GEOGLAM. The primary role of the Secretariat is to support the implementation of the Program. The Secretariat is the formal, outwardly liaising body of GEOGLAM to partner organizations and the Advisory Committee. The Secretariat provides logistical coordination and support for national, regional, and global activities. The Secretariat provides program reporting, program outreach, and communications, including management of the program web site. The Secretariat facilitates fundraising efforts and ensures that the financial contributions to GEOGLAM (in-kind, indirect, and direct alike) are levered as a part of this international program.

The GEOGLAM Executive Committee (Ex-Com). The GEOGLAM Executive Committee consists of three GEOGLAM Co-Chairs, thematic coordination and regional coordination co-Chairs, as well as leads of major large or strategic contributing initiatives, and the program director. The Ex-Com provides operational and strategic direction for the GEOGLAM Program, supports reporting on implementation progress and coordination across GEOGLAM's Thematic Areas. The Ex-Com is the implementation body, while the Director will be responsible for the day to day operation of the secretariat, participate in the ex-com, and provide financial accountability for dedicated resources through GEO. Wherever possible decisions are by consensus. Co-chairs of the Executive Committee will be nominated from major supporting institutions who are leaders in agricultural crop monitoring at the national and global scales. The co-chairs will work closely with the Director to develop the strategic direction for GEOGLAM. The Co-Chairs are selected from the community by vote of the Executive Committee, for a term of 3 years.

The GEOGLAM Thematic Coordination Teams & Regional Coordinators. The GEOGLAM Thematic Coordination Teams are led by the Thematic Coordination Co-Chairs. Similarly, the Regional Network Coordinators provide leadership for regional GEOGLAM implementation initiatives. The TCT's and RNC's consist of representatives of the projects, tasks and activities (both funded and in-kind) that contribute to achieving the GEOGLAM program goals and objectives. The TCT and RNC Co-Chairs provide input to the Executive Committee on project progress towards meeting the program and theme objectives as well as their perspectives on direction, planning, and development of the program.

The GEOGLAM Secretariat does not have sufficient capacity to establish an independent monitoring and evaluation function. However, it will meet these needs by participating in the GEO M&E activity, and GEOGLAM sees this as a major contribution from the GEO Secretariat. As well, financial management and accountability is managed through GEO administration. Notwithstanding the success of GEOGLAM, there are significant resourcing challenges. At the time of this draft all secretariat funding will expire by the end of 2019, posing serious risk to the continuity of these activities and GEOGLAM's ability to support GEO's 2020-2022 work programme. This risk is discussed further in the next section on resources.

7. Resources

The vast majority of GEOGLAM resources come from in-direct and in-kind funding of activities that contribute to GEOGLAM outcomes. This includes support for R&D as well as operational

implementation. This type of funding amounts to millions of dollars annually and some of the contributions are outlined in Table B. GEOGLAM participants have been very successful at attracting this funding from a wide variety of sources. Based on our track record, it is reasonable to assume this level of support will continue as long as GEOGLAM is active and delivering on its G20 policy mandate and keeping pace with the broader global policy agendas.

Direct funding needs for the GEOGLAM Secretariat are relatively small, but the role this plays is critical, as the Secretariat provides the “glue” that holds the entire initiative together. Current 2019 direct funding levels to support the Programme Director and operational needs of the Secretariat are approximately USD 400k per year from Germany and Canada, and as noted at the time of this draft (April 2019) it will terminate in November 2019. In addition to this support, there is also in-kind staff support for a Junior Project officer from China (ending June 2019) and on-going remote direct Secretariat support from the NASA Harvest program (ending 2022) for external liaising with and relationship leadership with the AMIS and CEOS on behalf of GEOGLAM. Consequently, in 2020 the NASA Harvest support may be the only resource available for the Secretariat.

Under the current management scenario, the funding level of about \$400k/year is required to “keep the lights on.” GEOGLAM has also prioritized incremental positions that we would implement if incremental resources became available at some point, and alternatively we will be exploring “no Geneva-based Secretariat” options later this year if no new resources are identified.

In light of the serious resource risk GEOGLAM is working with a resource mobilization consultant to develop a business case to support sustainable resource mobilization for GEOGLAM through the 2020-2022 Work Programme timeframe. The business case will be delivered mid-year and we are considering the creation of working Group to explore funding sustainability options going forward.

8. Technical Synopsis

GEOGLAM consists of many activities producing information products and tools focused on agricultural monitoring, as well as a very active research network producing peer reviewed papers that are used to drive the development of operational tools. These consume a variety of data. Space based data utilized by GEOGLAM are to-date primarily from free and open sources. GEOGLAM works with the Committee on Earth Observation Satellites (CEOS) to coordinate data access from civilian space agencies. Without this access to open data, GEOGLAM would not be possible. The nature of *in situ* data varies considerably depending on the source and location, and much of it is not openly available. Sources vary widely and include production insurance corporations, government sources, and academic institutions. There is no global source of *in situ* data for crop monitoring at this time, and this dearth of *in situ* data has further been broached with the CEOS agencies as it is a barrier to adoption of their considerable investments in Earth observing missions.

Due to the rich and complex variety of contributions to GEOGLAM it is not possible to do a technical synopsis of all activities here. We do however have two papers in review providing technical detail on the AMIS Crop Monitor and the Crop Monitor for Early Warning, and two in review on the ties between GEOGLAM and global policy drivers, focusing on the G20 and the SDGs. This work plan will be updated with a link to these papers when they are published. Beyond this we have provided links to some of the key sites below.

GEOGLAM Developed:

Crop Monitor for Agricultural Market Information System (AMIS) <https://cropmonitor.org/>, and published in <http://www.amis-outlook.org/>

Monthly updates about crop supply in major producer countries, including the G20 countries plus eight other large producers. These updates, which summarize the conditions of four major commodity crops (wheat, soybean, maize, and rice) have been included in the monthly AMIS Market Monitor publication since issue No. 11 published in September 2013.

Crop Monitor for Early Warning (CM4EW) <https://cropmonitor.org/>

AMIS Crop Monitor methods were adapted and applied to countries at risk of food production shortfalls. These countries, which represent nearly the inverse of the large market producers, are monitored and reported on in the Crop Monitor for Early Warning reports. First published in February 2016.

Joint Experiment for Crop Assessment and Monitoring (JECAM) <http://jecam.org/>

JECAM is an initiative created by the GEO Agriculture Monitoring Community of Practice with the intent to enhance international collaboration around agricultural monitoring towards the development of a “systems of systems” to address issues associated with food security and a sustainable and profitable agricultural sector worldwide.

GEOGLAM Earth Observation Data Requirements

(https://ec.europa.eu/jrc/sites/jrcsh/files/20180821-geoglam_ispra_2018_summary_final2.pdf)

The first version of the requirements (spatial, spectral, temporal, and coverage requirements by satellite missions) was produced between 2012 and 2014 in a time when both acquisition in the sub-100m domain and storage/compute/access were limited. Beginning in 2016, a “reboot” of the requirements was undertaken to capture the evolving state of the science, to take into account new civilian moderate resolution missions with free and open data policies, and to capitalize on the “cloud” and related advances in machine learning capabilities for handling large data volumes.

Partner Contributed:

ASAP <https://mars.jrc.ec.europa.eu/asap/>

ASAP is an online decision support system for early warning about hotspots of agricultural production anomaly (crop and rangeland), developed by the JRC for food security crises prevention and response planning anticipation. As part of its agricultural monitoring for food security activities, the JRC, in collaboration with external partners, has developed several open access desktop applications available for download.

Asia RiCE <http://asia-rice.org/>

Asia-Rice is the work of an ad hoc team of stakeholders with an interest in the development of an Asian Rice Crop Estimation & Monitoring (Asia-RiCE) component for the GEO Global Agricultural Monitoring (GEOGLAM) initiative.

- To ensure that Asian countries receive the full potential benefits of GEOGLAM, and that they are suitably engaged and prepared to do so;

- To ensure that rice crop monitoring issues are given suitable priority and attention within the scope of the full GEOGLAM initiative, including in the development of the observing requirements; and
- To establish a framework for the coordination necessary to engage, manage and support the various stakeholders.

CropWatch <http://www.cropwatch.com.cn/>

CropWatch assesses national and global crop production and related information using remote sensing and ground-based indicators. Each quarter, the group's findings are published in the CropWatch bulletin, which is issued in both English and Chinese. CropWatch contributes to the AMIS and early warning crop monitors for GEOGLAM, and CropWatch Cloud platform provides a suite of cloud-based tools for customized crop condition analysis.

NASA Harvest <https://nasaharvest.org/>

NASA Harvest is a multidisciplinary Consortium commissioned by NASA and led by the University of Maryland to enhance the use of satellite data in decision making related to food security and agriculture in the US and globally. It continues NASA's long-standing financial support of GEOGLAM activities.

MARS Crop Yield Forecasting System <http://agri4cast.jrc.ec.europa.eu/>

The JRC monitors European crops and forecasted crop yields and production since 1993. The main findings of the crop monitoring activities are collected in monthly MARS Bulletins published on the JRC website. Many of the MCYFS data and software are made freely available for access and reuse

Sen2Agri <http://www.esa-sen2agri.org/>

The Sen2-Agri system is an operational standalone processing system generating agricultural products from Sentinel-2 (A&B) and Landsat 8 time series along the growing season. These different products consist of:

- monthly cloud-free composites of surface reflectance at 10 – 20 m resolution;
- monthly dynamic cropland masks, delivered from the agricultural mid-season onwards;
- cultivated crop type maps at 10 m resolution for main crop groups, delivered twice along agricultural seasons;
- periodic vegetation status maps, NDVI and LAI, describing the vegetative development of crops each time a cloud-free observation is recorded.

The Sen2-Agri system is free and open source, allowing any user generating near real time products tailored to his needs at its own premises or on cloud computing infrastructure

Rangeland and Pasture Productivity (RaPP) <https://www.geo-rapp.org/>

RaPP is an initiative created with the aim to expand GEOGLAM's goals into the rangeland and pasture systems which sustain large part of the global livestock production. RaPP activities include:

- Global rangeland monitoring system, providing continuous observations of rangeland condition globally <https://map.geo-rapp.org/>. it includes Remote sensing observations of vegetation cover, ndvi and derived metrics, climate variables and land use, land cover and livestock relevant metrics. Allows the user to interact with the data and query time series information for any area of interest.

- Pilot sites – network of research sites for exchange and intercomparison of algorithms, methods and data for improving EO of rangeland systems
- Community of practice & outreach

9 Data Policy

GEOGLAM embraces the GEOSS Data Sharing Principles and has greatly benefited from open data sharing. The community operationally produces information products from this data and our work would not be possible without open data access. In turn our community produces information products that are made openly available to all. Indeed, the open and transparent approach to information development and dissemination is what allows GEOGLAM to be a trusted and authoritative source of information. Notwithstanding this, at this time GEOGLAM does not produce unique data, but rather functions as a consensus-building mechanism around best practices (e.g. via JECAM and the new CapDev Team) and available products and information (e.g. via the Crop Monitor). However, as described in Section 4, we do aspire to move towards the production of more quantitative estimates on agricultural state and change, and when we do so, they will be made openly available.

In general open sharing of in-situ data is a challenge for the GEOGLAM community. At the national level this data is often protected under law to prevent the disclosure of price information. At best this data can be accessed externally within projects only, under data sharing agreements. The same types of restrictions often occur when commercial EO data sources are utilized. The best examples of data sharing occur within the JECAM inter-comparison projects. Here in-situ data and commercial EO data is shared between participating research sites in order to test methods towards the development of best practices. Also, in a promising development ESA has recently launched the Sens4Stats project with the intent to develop tools to extract in-situ data to support EO analysis while preserving the confidentiality of the data sources. GEOGLAM believes these efforts will help to move the bar on in-situ data sharing, but much is still to be done to realize universal open sharing.

In the current state, GEOGLAM intellectual property is distributed across several sites. This includes methods, algorithms, software tools and data. In the short term we will be redesigning the GEOGLAM website in the summer of 2019, with the intent of better linking these assets. Longer term we look toward the development of the GEO knowledge Hub to provide a home for GEOGLAM data, information, best practices, tools and algorithms. To this end we are fully supporting the knowledge hub proposal and providing support to develop the proof of concept for its approval at the 2019 GEO plenary.

A final issue with respect to data policy and intellectual property management is our engagement with the commercial sector. We already have some success in this area, in particular with re-insurance and agricultural commodity interests like the global grains commission. We have also had some success working with the commercial EO sector to obtain imagery to support our R&D activities. Recently there has been interest from the private sector to contribute to our crop monitors. In this respect we are proceeding carefully, as our impartiality and independence is critical to the authority of our information. We continue to explore these opportunities and work to understand the inherent value proposition for the commercial sector and GEOGLAM. In this regard

the GEO commercial engagement guidelines have been quite useful and further leadership from the GEO Programme Board would be most welcomed as we navigate these opportunities.