NASA Science Mission Directorate
Earth Science Division
Applied Sciences Program

Global Agriculture and Drought Monitoring

Brian Barker

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Department of Geographical Sciences, UMD**

PI: Inbal Becker-Reshef

NASA Water Resources PI Meeting, April 26-28, 2016

Framework: GEOGLAM

A GEO Initiative on Global Agricultural Monitoring through the use of earth observations

- Aim: Strengthen the international community's capacity to produce and disseminate relevant information on agricultural production at national, regional and global scales, through earth observations
- Building on existing monitoring systems & complementary to them
- Focus on 'producer' countries and 'countries-at-risk'
- Adopted by G-20 in 2011 under Action Plan on Food Price Volatility and Agriculture
- http://www.earthobservations.org/geoglam.php

GEOGLAM Components

1. GLOBAL/ REGIONAL SYSTEM OF SYSTEMS

Main producer countries, main crops

AMIS Crop Monitor

2. NATIONAL CAPACITY DEVELOPMENT

for agricultural monitoring using Earth Observation

National Crop Monitors

3. MONITORING COUNTRIES AT RISK

Food security assessment

Component led by FEWS NET (J. Verdin) and EC JRC

Early Warning Crop Monitor

4. EO DATA COORDINATION

CEOS Committee on Earth Observation Satellites

5. METHOD IMPROVEMENT through R&D coordination (e.g. JECAM)

6. Data, products and INFORMATION DISSEMINATION

Challenges

•Need: Timely, reliable, policy-relevant crop condition assessments that reflect and international consensus

- highlighting potential hotspots of stress/bumper crop

Opportunity

•G-20 Policy Mandate with well defined, active user communities

•Bring international operational community to develop consensus reports, reducing uncertainty and increasing confidence in crop assessments, for informing agricultural policy, and food security decisions

- Increase the use of EO based information, products to inform decisions on food security, policy and markets
- Foster closer working relationship between the EO ag community and the economics/policy community

Current partners and user community

- Two operational Crop Monitor systems developed and one national system in development with 3 unique user communities:
  - **Crop Monitor for the Agricultural Market Information System (AMIS)**
    - Focus on the main production/export countries
    - Informing international markets, in support of market stability and reduced volatility
    - Over 35 international, regional and national partners
  - **Early Warning Crop Monitor**
    - Focus on countries at risk of food insecurity
    - Current partners are the main agencies monitoring food security
    - Expanding to include regional networks, and national sources
    - Discussions with SADC, FAO GIEWS, SERVIR Hubs, MESA,
  - **Tanzania Crop Monitor** (in development)
    - Focus on subnational conditions for informing national policy
    - Partners: Ministry of Agriculture (MALF)

AMIS Crop Monitor overview

- Objective: develop transparent, timely, crop condition assessments in primary agricultural production areas highlighting potential hotspots of stress/bumper crop
- Reflecting an international consensus of crop conditions, building on existing systems
- Four major crops: wheat, maize, soybean, rice (9 total seasons)
- Response to G-20 AMIS request
- Focus: stabilizing/calming markets
- End Users: AMIS Community
- http://www.geoglam-crop-monitor.org

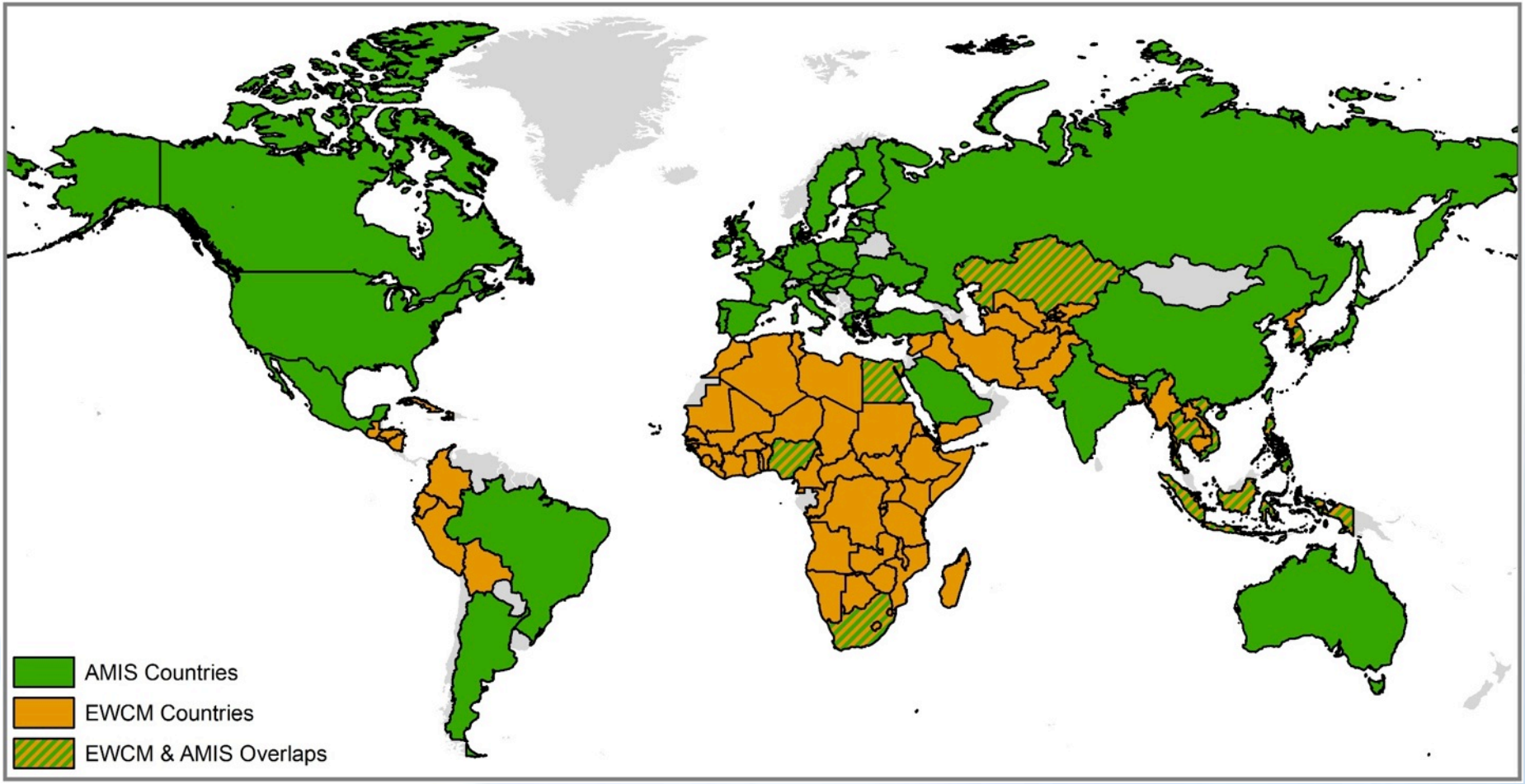
GEOGLAM AMIS Crop Monitor Partners

> 35 Partners and Growing

Early Warning Crop Monitor Current and Prospective partners

- Priority is to expand to include regional network and national partners including ministries of agriculture
- Currently missing partners to cover: North Africa, Middle East and South America
  - Working with FEWS NET and JRC to explore potential partners who can cover these including:
  - SADC, ICPAC, and AGRHYMET

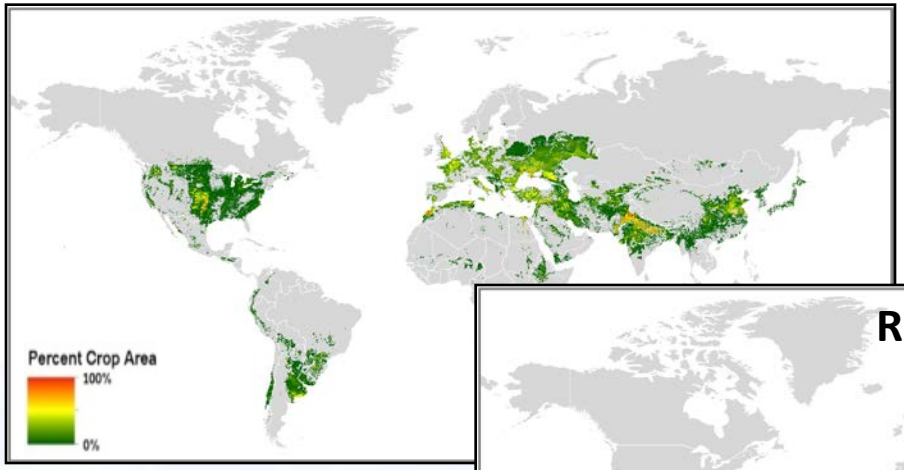
EWCM Vs. AMIS Countries



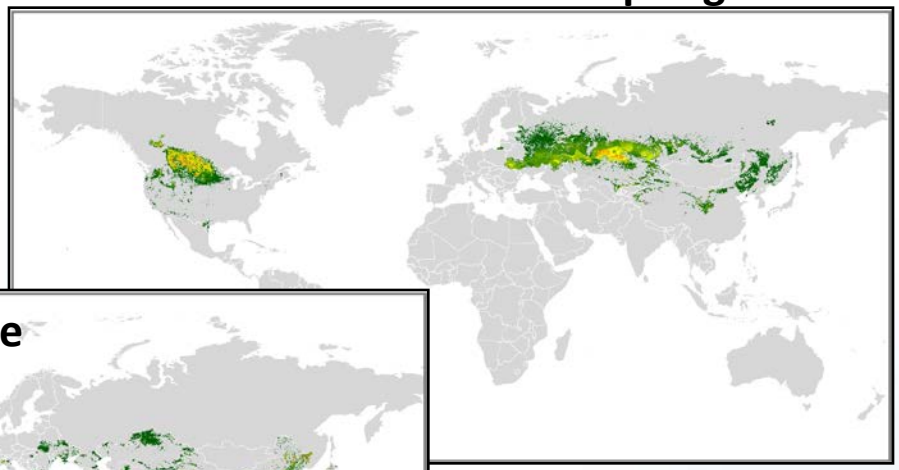
Key datasets, models, scientific, technical tools

GEOGLAM Best Available Multi-Season Crop Masks

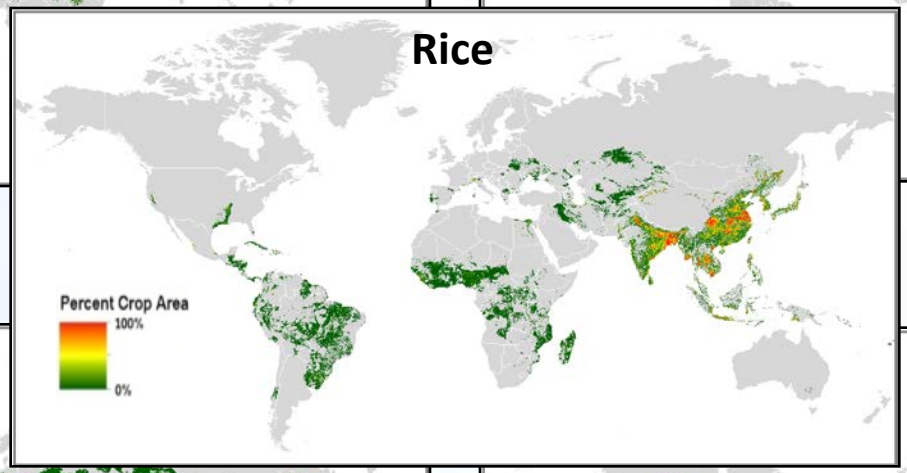
Winter Wheat



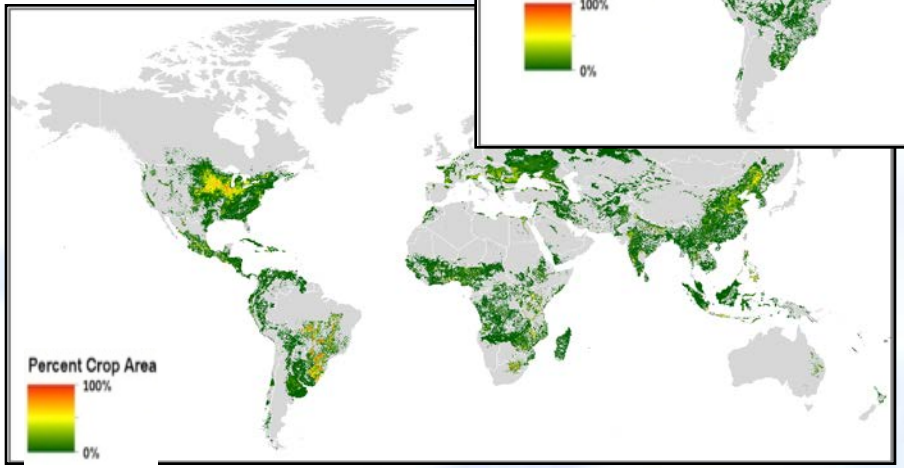
Spring Wheat



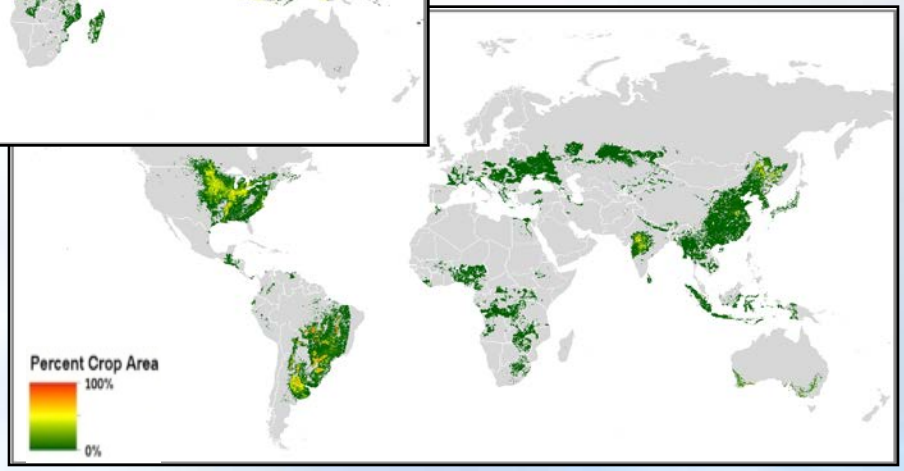
Rice



Maize

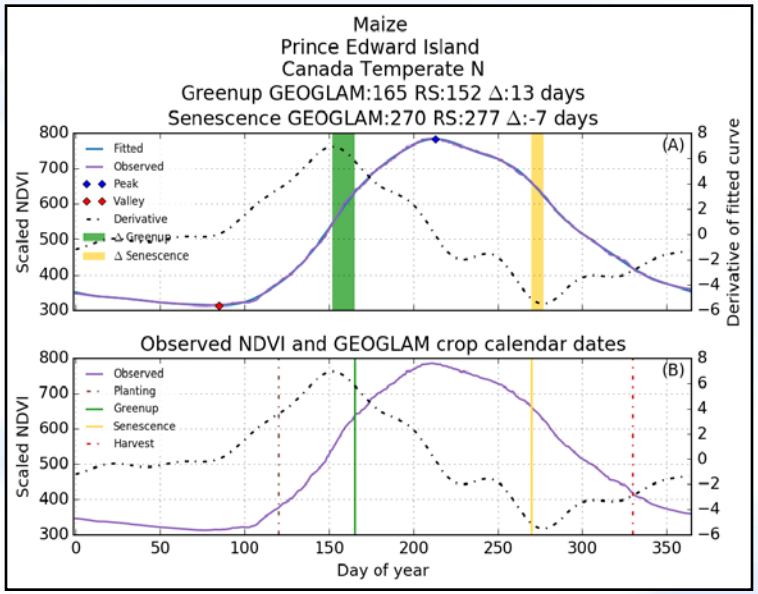


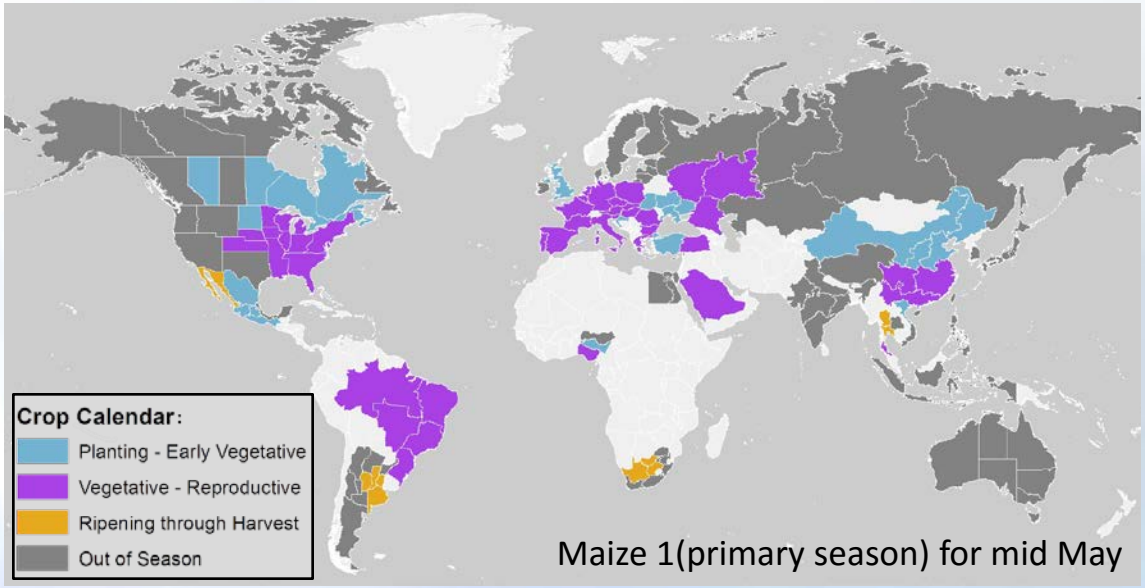
Soybeans



GEOGLAM Best Available Multi-Season Crop Calendars

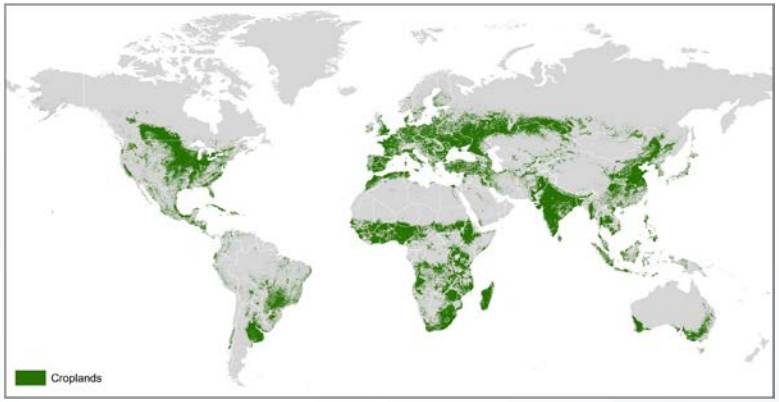
- Built upon USDA and FAO crop calendars and then refined with inputs from our in country partner agencies at a sub-national level
- Broken down into crop stages to help identify critical periods of development
- Currently undergoing RS based validation

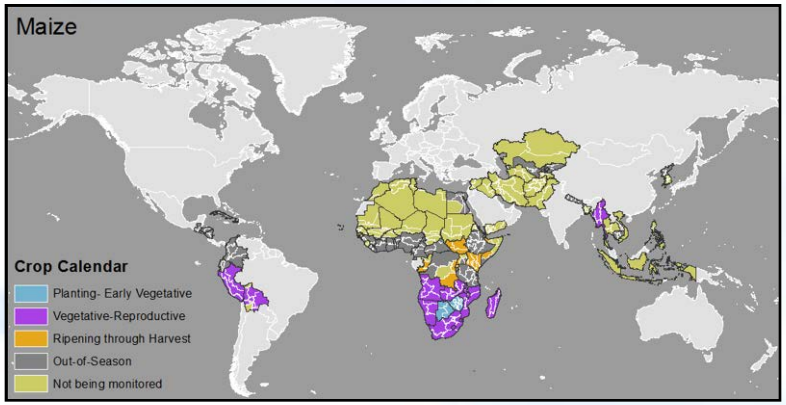




EWCM Cropland mask and crop calendars

- Current mask based on IIASA-IFPRI Global Cropland Map and AfSIS Probabilities of Croplands





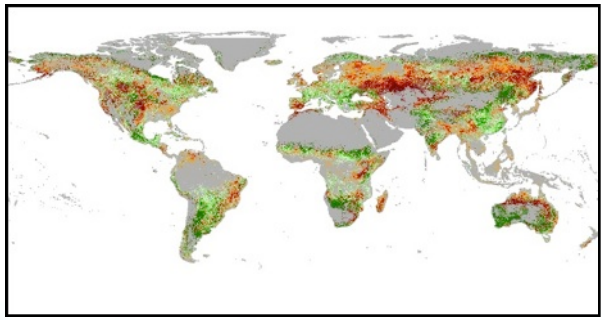
- Crop calendars covering 10 crops
- Across 81 different countries
- Regional and in country field analysts assisting their development into multi-season and stage specific calendars

Project Title: Global Agriculture and Drought Monitoring

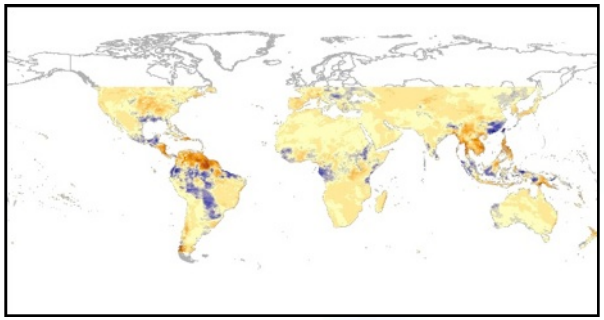
Examples of the available EO Data layers

Including several from NASA Applied Sciences Projects

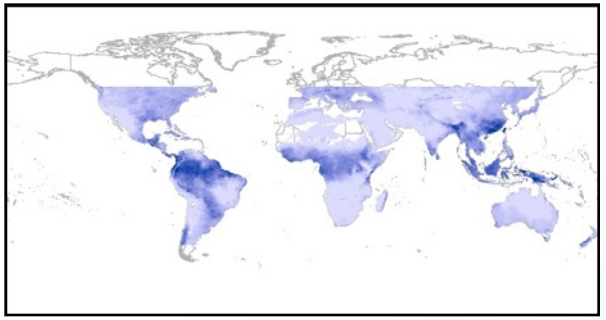
USGS – Actual ET Anomaly



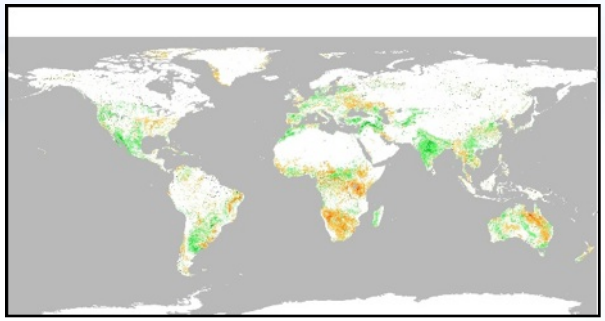
USGS/CHG – CHIRPS Rainfall Anomaly



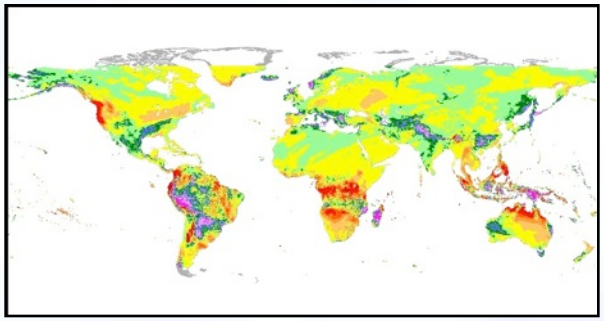
USGS/CHG – CHIRPS Total Rainfall



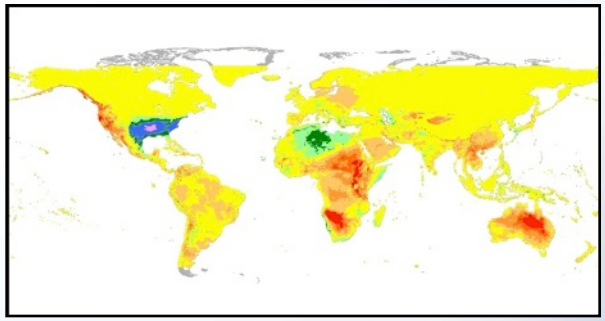
UMD/NASA – NDVI Anomaly



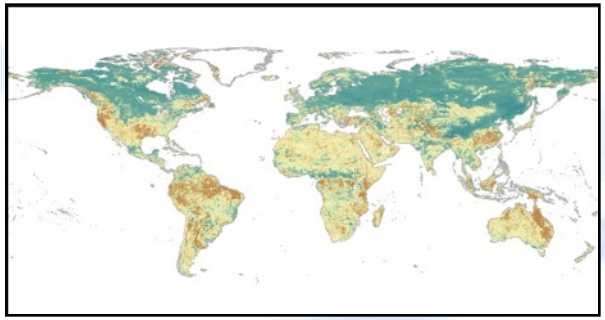
JRC – Rainfall Sum Anomaly



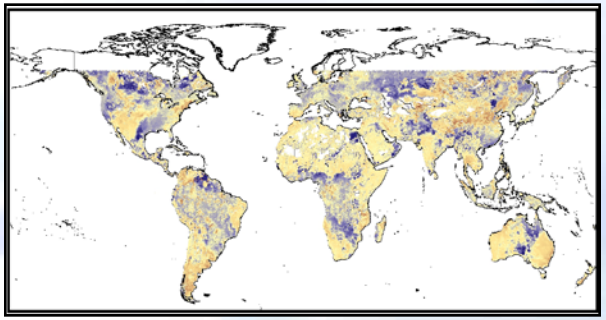
JRC – Temp Sum Anomaly



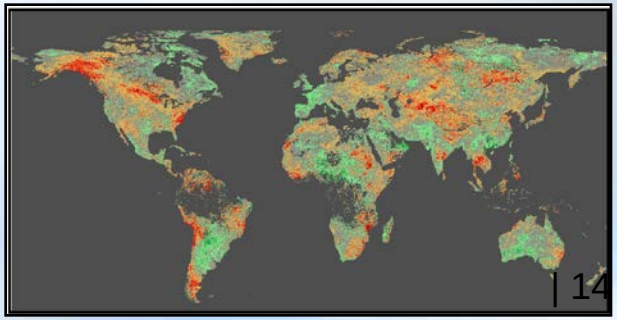
TU WIEN – Soil Water Index Anomaly



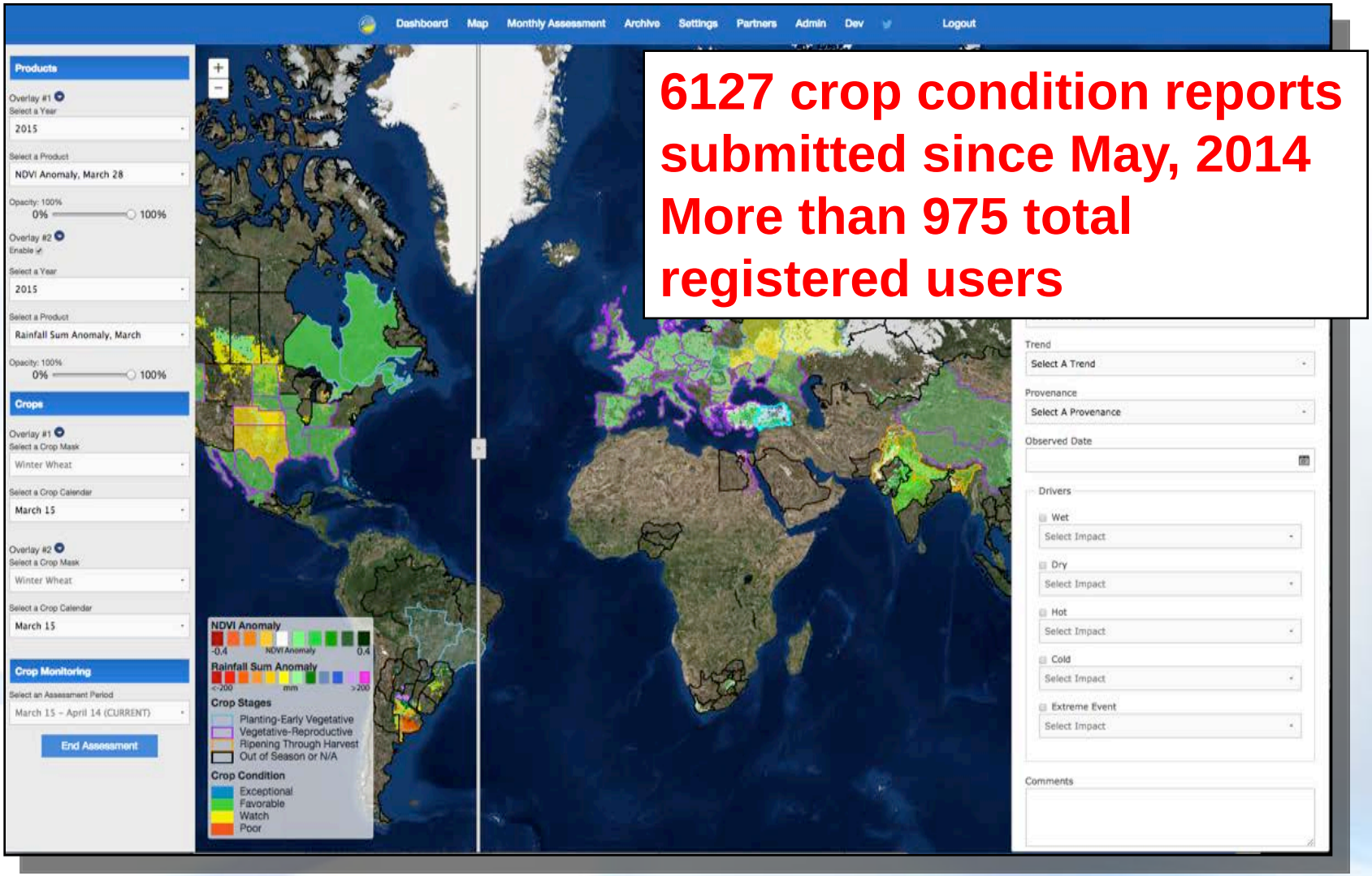
NASA/USDA– Soil Moisture Anomaly



NOAA/USDA ARS – ESI

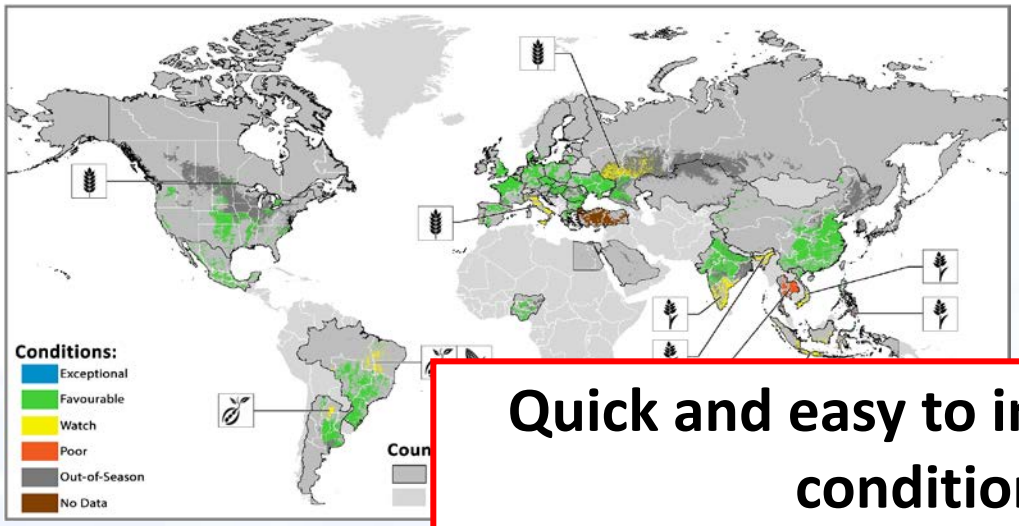


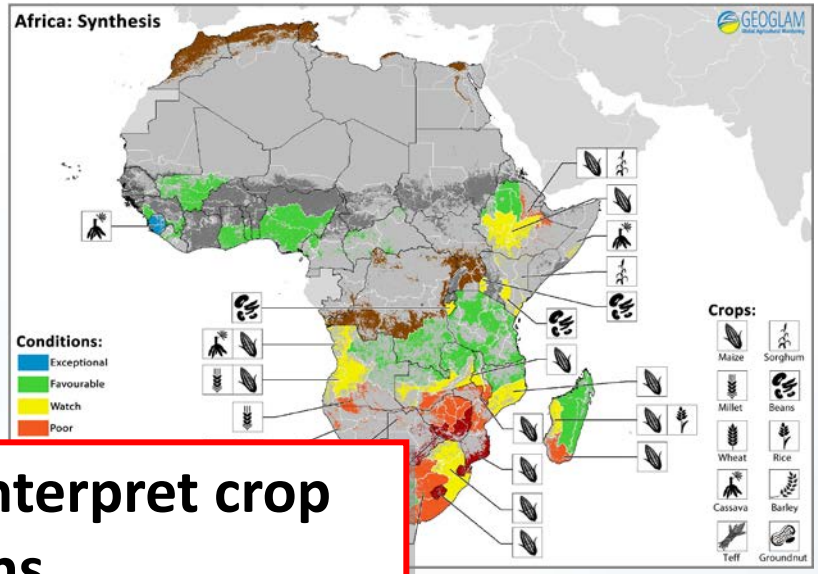
Crop Interfaces for Crop Condition Assessments



6127 crop condition reports submitted since May, 2014
More than 975 total registered users

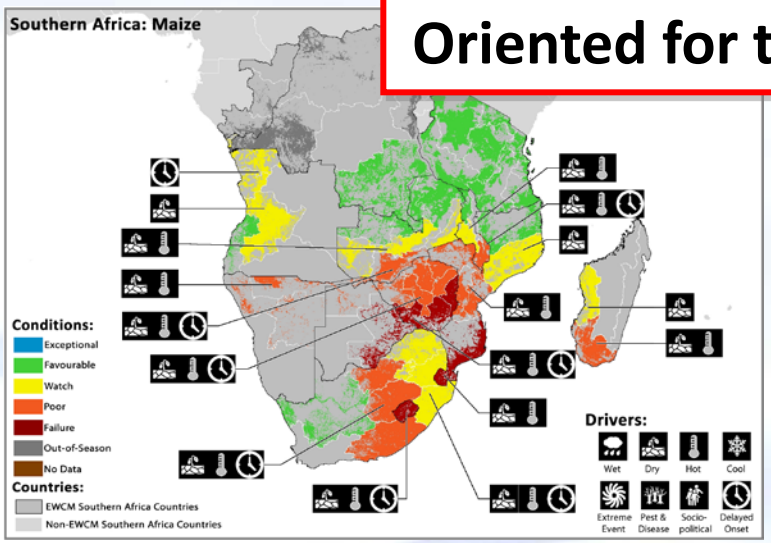
Products: Maps

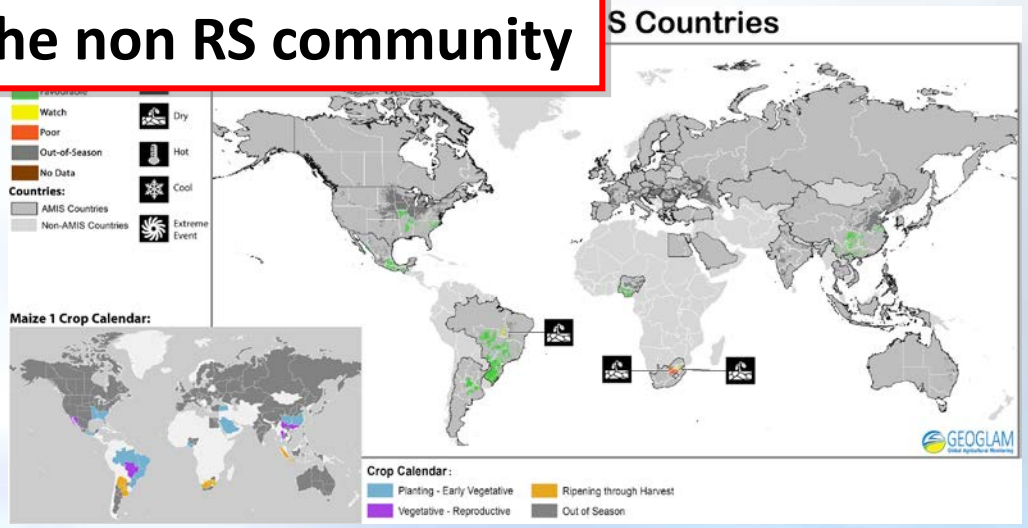




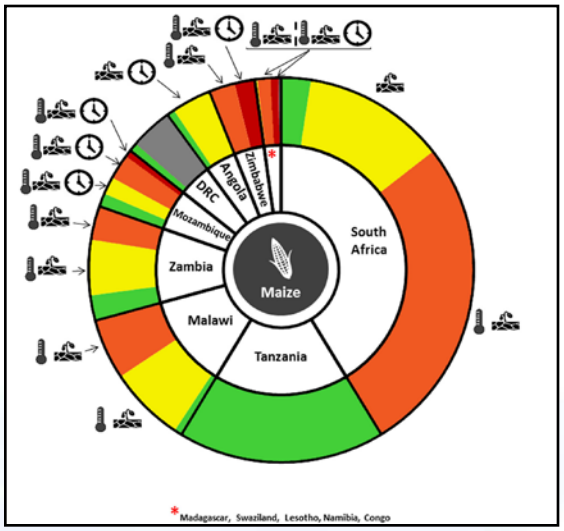
Quick and easy to interpret crop conditions

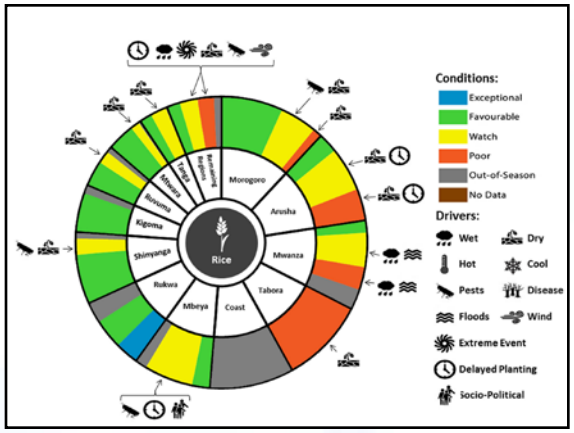
Oriented for the non RS community

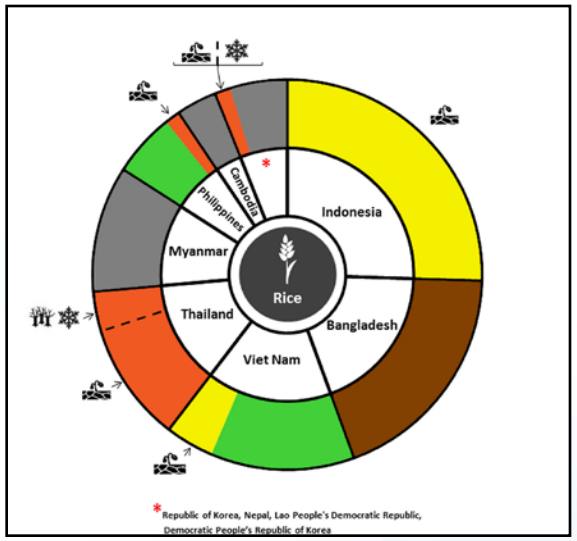


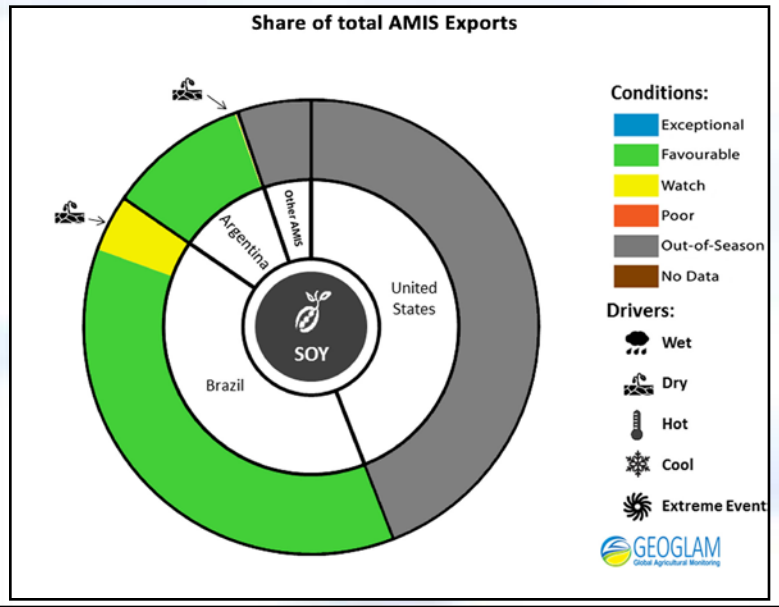


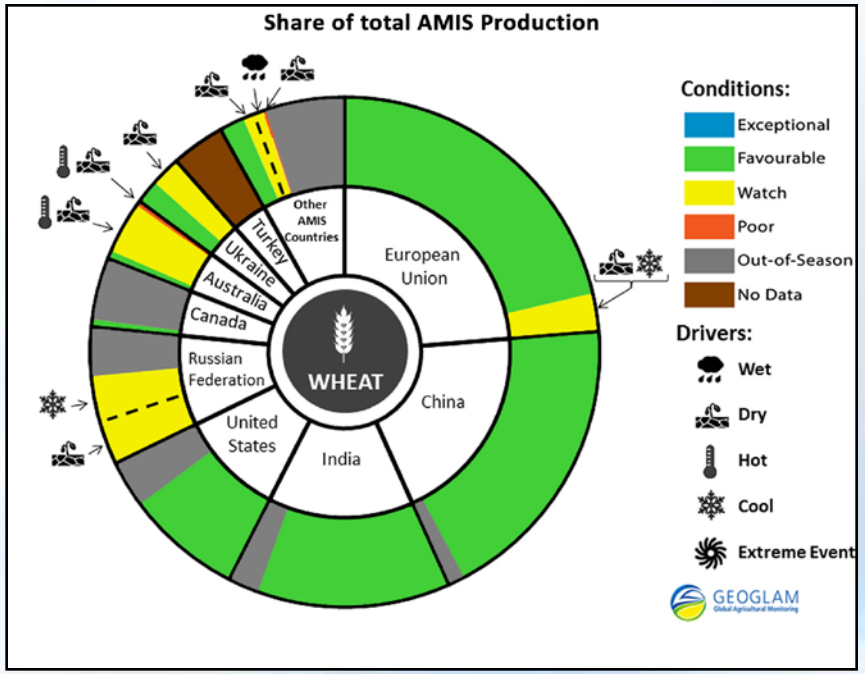
Products: Pie Charts











Approach

1. Partners submit crop condition information, data, and fill out information on the online Crop Assessment Tool
2. Compile submitted information into a report and produce discrepancy maps
3. Review and discuss report and discrepancies over partner telecon
4. Update assessment and send out for GEOGLAM review
5. Submit draft for AMIS review (AMIS CM) or for partner review for the EWCM
6. Update if new information becomes available prior to release
7. Release both Crop Monitors on the first Thursday of the month

Total process is ~ 10 days

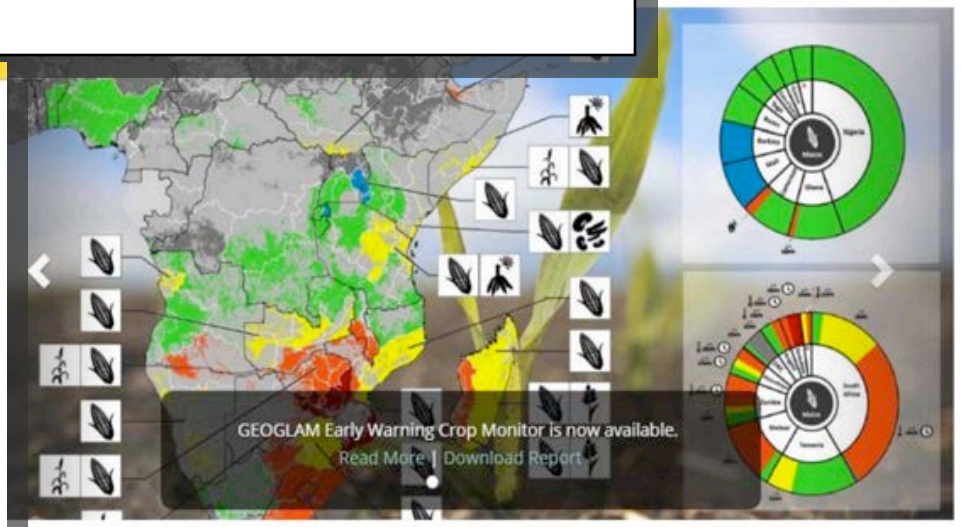
Impacts: In the Media

GEO Announces Launch of Early Warning Crop Monitor: A New Tool to Fight Food Insecurity

GEO's US Co-Chair, Dr Kathryn Sullivan, Administrator of the US National Oceanic and Atmospheric Administration (NOAA), stated, "Concerns over food and water security are rising globally. Ensuring that agricultural industries around the world have access to the best science, data, tools and resources is essential as we work to increase food security and mitigate the effects of droughts and floods. The GEOGLAM Early Warning Crop Monitor provides decision-makers with essential information, gathered from satellites, buoys and other observational tools, to be ready, responsive and resilient against extreme weather and water events."

GeoExpress Software

Early Warning Crop Monitor, a during the GEO 36th Executive



eveloped by the GEO Global Agricultural Monitoring Initiative (GEOGLAM), initiated by the G-
Agriculture Ministers, the Early Warning Crop Monitor (ECWM) provides consensus reports on crop conditions in countries at risk of food insecurity in Central and South America, Africa,

Business / Land & Agriculture

Dry and brown Southern Africa will need food aid

BY EMIKO TERAZONO AND ANDREW ENGLAND, FEBRUARY 15 2016, 05:52

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FEWS NET

FEWS NET Special Report

SOUTHERN AFRICA Special Report March 18, 2016

Illustrating the extent and severity of the 2015-16 drought

A severe drought, related to El Niño, is ongoing across the Southern Africa region. This drought has limited crop production and exacerbated the current lean season. While April/May harvests will provide some temporary relief, food insecurity during the 2016/17 consumption year is expected to be severe. This report presents a series of maps which illustrate the extent and the severity of the drought as well as its impacts on water availability, crop and rangeland conditions, food prices, and food security. For a more detailed narrative and analysis of the drought's current and expected impacts on food security, please visit www.fews.net/south.

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THE HERALD

Zimbabwe: WFP Extends F

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THE United Nations' World Food Programm announced that it would this year -- for the suspend food aid in March but continue to Zimbabweans until next year.

In a statement released yesterday, WFP sa "period of bounty" and will continue offering the year into next year.

Vegetation Status and Crop Production Perspectives

Southern Africa: Maize

Drivers:

Left: NDVI in late February 2016, as a percentage of a 12-year average. Orange shades indicate below-average vegetation; green shades indicate above-average vegetation. Right: Maize production perspectives from a multi-agency assessment (GEOGLAM)

Southern Africa: A Season of Regional Drought

WFP VAM Report

Southern Africa Growing Season 2015-2016:

A Season of Regional Drought

vam food security analysis

spread drought. A joint assessment of crop production perspectives carried out by D) confirms a very pessimistic picture across most of the region: the situation is nerally poor production in the rest of the country. Similar outcomes extend to the nbique can also expect crop failures in its southern regions. Only regions such as northern Mozambique, Tanzania, northeast Zambia, northern Malawi and parts of Angola face normal production scenarios, as they benefit from El Nino induced rainfall enhancements typical of East Africa.

South Africa's maize production estimates for this season have been revised downwards slightly in February, to about 7.2 million tons, 27 percent below last year's and 38 percent below the 5 year average. The USDA Foreign Agriculture Service is more pessimistic, estimating production at 6.5 million tons. Similar variations may be expected for Zimbabwe, possibly Mozambique and Malawi, with more moderate losses in Zambia.

Southern Africa to face severe food crisis

Friday 25 March 2016 09:40

ANA

Two years of consecutive drought has limited crop production.(SABC)

The Famin (FEWSNET insecurity a 2016-2017 drought wh

In a new sp extent and FEWSNET expected fr April/May, Monitor (E 28, crop fa Swaziland, Zimbabwe

Crop condi western Ma Malawi, no producing Mozambiqu

TAGS:

Famine Early Warning System Network Drought GEOGLAM Early Warning Crop Monitor EWCM Botswana FEWSNET Food insecurity Zimbabwe Malawi Mozambique Zambia Lesotho Madagascar

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FINANCIAL TIMES

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South African corn withers amid worst drought on record

Impact of ex

Comment Now

Southern Africa warned of severe food crisis

AFRICA Thursday 24 March 2016 - 4:04pm

WFP World Food Programme

FEWS NET

Food and Agriculture Organization of the United Nations

Joint Statement

El Niño Set to Have a Devastating Impact on Southern Africa's Harvests and Food Security

(FEWSNET) has warned in 2016-2017 after two years of consecutive drought which have limited crop production.

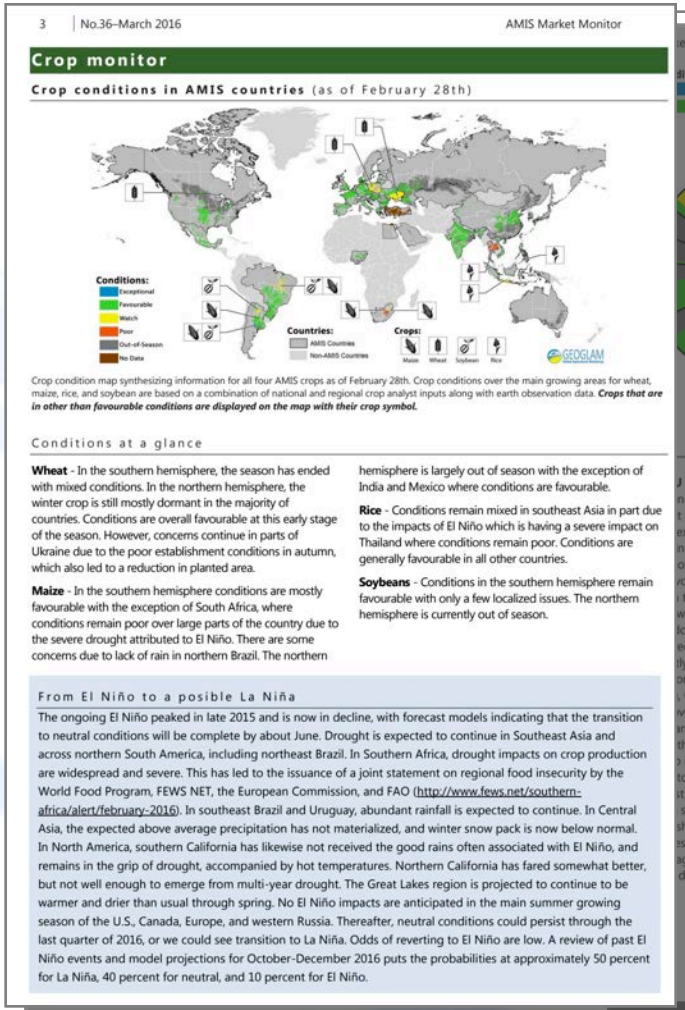
In a new special report entitled "Illustrating the extent and severity of the 2015-2016 drought," FEWSNET said although temporary relief was expected from the harvests expected in April/May, the GEOGLAM Early Warning Crop Monitor (EWCM) has shown that as of February 28, crop failure had been confirmed in Lesotho, Swaziland, southern Mozambique, southern Zimbabwe and eastern Botswana.

Social Media: Twitter

- Currently have over 600 followers
- We've been retweeted by FAO, GEO, FEWS NET, CIMMYT, EO4InnovationEU, AMIS, USAID and many, many others
- In the past 90 days, our EWCM images have been retweeted or "liked" 91 times
- In the past 90 days, our AMIS CM images have been retweeted or "liked" 158 times

Crop Monitor for AMIS

Published monthly within the Market Monitor (26 issues published)



3 | No.36–March 2016 AMIS Market Monitor

Crop monitor

Crop conditions in AMIS countries (as of February 28th)

Crop condition map synthesizing information for all four AMIS crops as of February 28th. Crop conditions over the main growing areas for wheat, maize, rice, and soybean are based on a combination of national and regional crop analyst inputs along with earth observation data. ***Crops that are in other than favourable conditions are displayed on the map with their crop symbol.***

Conditions at a glance

Wheat - In the southern hemisphere, the season has ended with mixed conditions. In the northern hemisphere, the winter crop is still mostly dormant in the majority of countries. Conditions are overall favourable at this early stage of the season. However, concerns continue in parts of Ukraine due to the poor establishment conditions in autumn, which also led to a reduction in planted area.

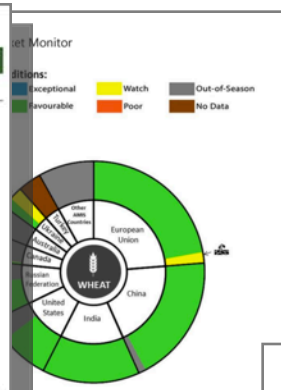
Maize - In the southern hemisphere conditions are mostly favourable with the exception of South Africa, where conditions remain poor over large parts of the country due to the severe drought attributed to El Niño. There are some concerns due to lack of rain in northern Brazil. The northern hemisphere is largely out of season with the exception of India and Mexico where conditions are favourable.

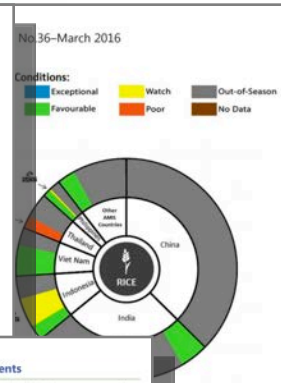
Rice - Conditions remain mixed in southeast Asia in part due to the impacts of El Niño which is having a severe impact on Thailand where conditions remain poor. Conditions are generally favourable in all other countries.

Soybeans - Conditions in the southern hemisphere remain favourable with only a few localized issues. The northern hemisphere is currently out of season.

From El Niño to a posible La Niña

The ongoing El Niño peaked in late 2015 and is now in decline, with forecast models indicating that the transition to neutral conditions will be complete by about June. Drought is expected to continue in Southeast Asia and across northern South America, including northeast Brazil. In Southern Africa, drought impacts on crop production are widespread and severe. This has led to the issuance of a joint statement on regional food insecurity by the World Food Program, FEWS NET, the European Commission, and FAO (http://www.fews.net/southern-africa/alert/february-2016). In southeast Brazil and Uruguay, abundant rainfall is expected to continue. In Central Asia, the expected above average precipitation has not materialized, and winter snow pack is now below normal. In North America, southern California has likewise not received the good rains often associated with El Niño, and remains in the grip of drought, accompanied by hot temperatures. Northern California has fared somewhat better, but not well enough to emerge from multi-year drought. The Great Lakes region is projected to continue to be warmer and drier than usual through spring. No El Niño impacts are anticipated in the main summer growing season of the U.S., Canada, Europe, and western Russia. Thereafter, neutral conditions could persist through the last quarter of 2016, or we could see transition to La Niña. Odds of reverting to El Niño are low. A review of past El Niño events and model projections for October-December 2016 puts the probabilities at approximately 50 percent for La Niña, 40 percent for neutral, and 10 percent for El Niño.





Contents

AMIS MARKET MONITOR

No.36 – March 2016

Roundup

In spite of small downward adjustments to 2015 wheat, maize and rice production this month, the overall supply prospects for these three AMIS crops remain favourable. Soybeans markets are also well supplied, with the latest forecast for 2016 global inventories raised to above their already record opening. The early outlook for wheat production in 2016 points to only a small decrease from the 2015 record.

Markets at a glance

	From previous forecast	From previous season
Wheat	▼	▲
Maize	-	-
Rice	-	▼
Soybeans	▲	▲

▲ Easing - Neutral ▼ Tightening

The **Market Monitor** is a product of the Agricultural Market Information System (AMIS). It covers the international markets for wheat, maize, rice and soybeans, giving a synopsis of major market developments and the policy and other market drivers behind them. The analysis is a collective assessment of the market situation and outlook by the ten international organizations that form the AMIS Secretariat. Visit us at www.amis-outlook.org

Soybeans

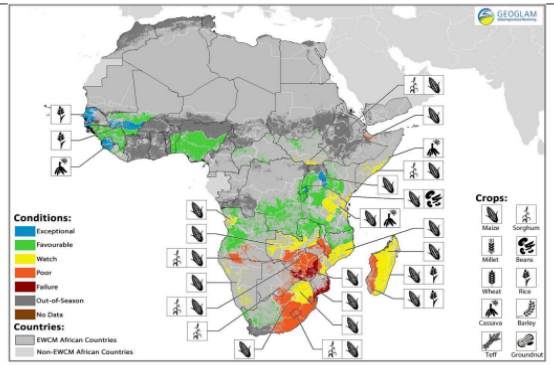
In **Brazil**, the crop is largely in vegetative to reproductive stages in the southern, north and northeast regions and is in ripening through harvesting stages in the rest of the country. The crop is in mixed condition in the north and northeast due to a lack of rainfall but favourable in the rest of the country. In **Argentina**, conditions remain mostly favourable but there are some areas affected by excess moisture from this month and lingering dry issues from January. The first crop is mostly in grain filling to maturity stages, and the second crop is in flowering to grain filling stages.

Project Title: Global Agriculture and Drought Monitoring

The First EWCM Bulletin Released February 2016 3 published to date

GEOGLAM Early Warning Crop Monitor

Crop Conditions at a glance as of January 28th



Crop condition map synthesizing information for all EWCM crops. Crop conditions over the main growing areas are based on a combination of national and regional crop analyst inputs along with earth observation data. **Crops that are in other than favourable conditions are displayed on the map with their crop symbol**

SOUTHERN AFRICA: A severe drought driven by El Niño is impacting croplands across southern Africa leading to significant reductions in planted area and to poor conditions and failed crops across broad areas.

EAST AFRICA: Current conditions are mostly favourable, however poor rainfall distribution and quantity affected parts of Kenya, Somalia and Tanzania. The recently concluded Meher harvest in Ethiopia was very poor due to the severe drought conditions that prevailed during the main June-September rainy season of 2015.

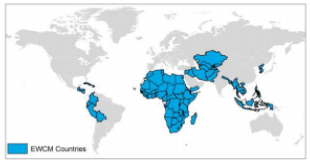
WEST AFRICA: Currently the majority of the region is out of season. End of season conditions were largely favourable over the growing regions with the exception of a few areas in Ghana, Cameroon and Chad, which had experienced poor rainfall distribution, towards the end of the season.

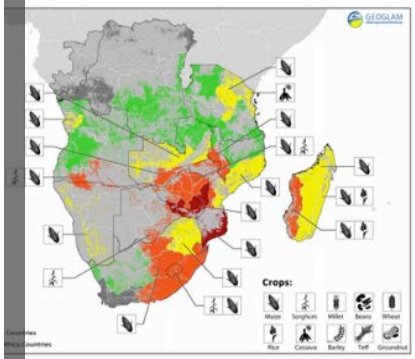
El Niño

The El Niño of 2015-2016 peaked in late November-early December, but remains strong and will only decline to neutral around June. The growing season in South Africa has been characterized by severe drought, with many crop growing areas having their driest early season since 1981. As a consequence, maize production is projected to be down by 35% compared to average, and imports to the region will be required to meet needs both nationally and in neighbouring countries that are likewise drought stricken. Drought is expected to continue in Southeast Asia and across northern South America.

The GEOGLAM Early Warning Crop Monitor (EWCM):

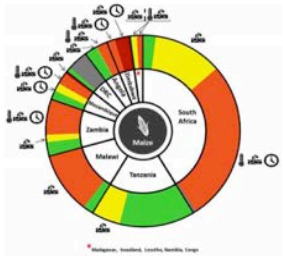
Brings together the international, regional, and national organizations monitoring crop conditions within countries at risk of food insecurity. The focus is on developing timely consensus assessments of crop conditions, recognizing that reaching a consensus will help to strengthen confidence in decision making. The EWCM grew out of a successful collaborative relationship, the AMIS Crop Monitor, which monitors the main producing countries (http://www.amis-outlook.org/). This is the first bulletin but future EWCM assessments will include all countries shown in blue in the adjacent panel.



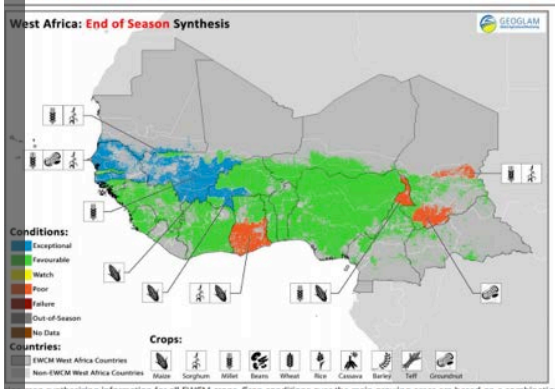


…mation for all EWCM crops. Crop conditions over the main growing areas are based on a combination of …ts along with earth observation data. **Crops that are in other than favourable conditions are displayed on**

…cing an intense drought …ngest El Niño events of the …ze crop has been impacted …s, significant reductions in …conditions for early crop …reas. Seasonal forecasts …tions will continue through …h Africa, which is ordinarily …production is projected to …ons of people will require …2016-2017, notably in …mbique, Lesotho, and …outside the region will be …t should be noted that this …-2015 in large parts of the

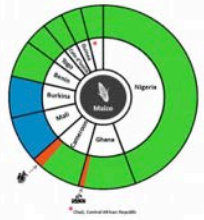


…frica: End of Season Conditions



…ion map synthesizing information for all EWCM crops. Crop conditions over the main growing areas are based on a combination of …d regional crop analyst inputs along with earth observation data. **Crops that are in other than favourable conditions are displayed on …th their crop symbol**

…ty of the region is out of season and the end of season …are largely favourable. In West Africa and part of …frica (Chad, Cameroon, CAR), the start and end of …atitude dependent. The length of the growing period …in the south where it starts in March and ends in …ovember and shorter in the north where it starts in …nds in October. The region also includes a bi-modal …e the long season starts in March and ends in July and …eason starts in September and ends in November, the …eparated by a brief dry season that lasts for about a …d takes place normally in August. In the uni-modal …start of the season was characterized by poor rainfall …particularly in the Sahelian and Sudanian-Sahelian …ere planting was delayed. However, the months of July, …d September were generally characterized by average …verage and well distributed rains except in the eastern …e Sahel that suffered from poor rainfall distribution …e end of the season in late September and early …Growing conditions have been favourable over the …-climatological zones. In the bi-modal zone, however, …dry season started earlier than normal and extended through mid-September, resulting in a production shortfall, particularly for maize.



…rt description

…ents a country's share of total average regional production, in the case of the regional charts, and total national production in the case of the national charts. Sections within …re weighted by the average sub-national production statistics of the respective country.

…Disclaimers: The Crop Monitor assessment is conducted by GEOGLAM with inputs from the following partners FEWS NET, JRC, WFP and UMD. The findings and conclusions …ulti-agency report are consensual statements from the GEOGLAM experts, and do not necessarily reflect those of the individual agencies represented by these experts. …r information on the GEOGLAM crop assessments is available at www.geoglam-crop-monitor.org

Lessons Learned

- Working closely with user community is critical!
  - Understanding user needs- took over a year to develop jointly the current crop monitor maps and charts working closely with the economics/policy community
- Ensure appropriate R&D informs the development of the system
- Information products have to be simple!
- Done is better than perfect
  - Became operational first and evolve products and process as we go
- Community building
- Much that the RS community can offer the policy community- critical to build bridges, and continue to work together

Next Steps

Still very much a work in progress..

- Continued R&D on EO based crop condition indicators
- Continue to expand partners to include regional networks and national systems (EWCM)
- Develop/enhance best available baseline products
  - Cropland and crop type masks, calendars, stats, marginal vs high production areas
- Expand end of season products and bulletins
- Inclusion of basic relevant markets information (EWCM)

Summary

- Effective & scalable mechanism for coordination of crop assessments
- First time the international community comes together on a monthly basis to produce joint assessments that reflect a consensus
- End user driven with strong community, high level support & a political mandate
- Already proven to be highly valuable resource with high level support and international interest

Publications

Operational Monthly Publications

•GEOGLAM Crop Monitor, (lead monthly publication- 27 issues released to date). Published within the G-20 Agricultural Market Information System (AMIS) Market Monitor. (http://www.amis-outlook.org/amis-monitoring/monthly-report/en/) (with inputs and reviewed by over 35 international and national agencies).

•G20-GEOGLAM Early Warning Crop Monitor (lead monthly publication, 3 issues to date). www.cropmonitor.org. (With inputs and reviewed by USAID FEWS NET, UN World Food Programm, EC- JRC, ARC, Asia-RiCE).

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News, Press Releases, Official Reports

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- **GEO Secretariat Press Release**: GEO Announces a New Tool to Fight Food Insecurity. March 18th 2016. Geneva:
- (https://www.earthobservations.org/documents/pressreleases/pr_201603_crop_monitoring.pdf)
- **GEO Secretariat.** New GEOGLAM tool predicts severe crop losses in Southern Africa. Feb 28th, 2016. https://www.earthobservations.org/articles_news.php?id=158
- **UN World Food Programme Seasonal Monitor.** Southern Africa Growing Season 2015-2016: A Season of Regional Drought. Vulnerability Analysis and Mapping Unit (VAM).March 2016. (http://documents.wfp.org/stellent/groups/public/documents/ena/wfp282670.pdf)
- **USAID FEWS NET, UN WFP, UN FAO, and EC-JRC Joint Press Release**: El Nino Set to Have a Devastating Impact on Southern Africa's Harvests and Food Security. February 12 2016. **(**can be downloaded from all 4 agencies. **https://www.wfp.org/news/news-release/el-nino-set-have-devastating-impact-southern-africas-harvests-and-food-security).**
- **USAID FEWS NET Special Report.** Illustrating the extent and severity of the 2015-16 drought. March 2016. http://www.fews.net/southern-africa/special-report/march-2016
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