



# The GEO Global Agricultural Monitoring (GEOGLAM) initiative and NASA Harvest: Consortium on Global Agriculture and Food Security

Chris Justice (University of Maryland)

# GEOGLAM Launched by the G20 Agriculture Ministers 2011



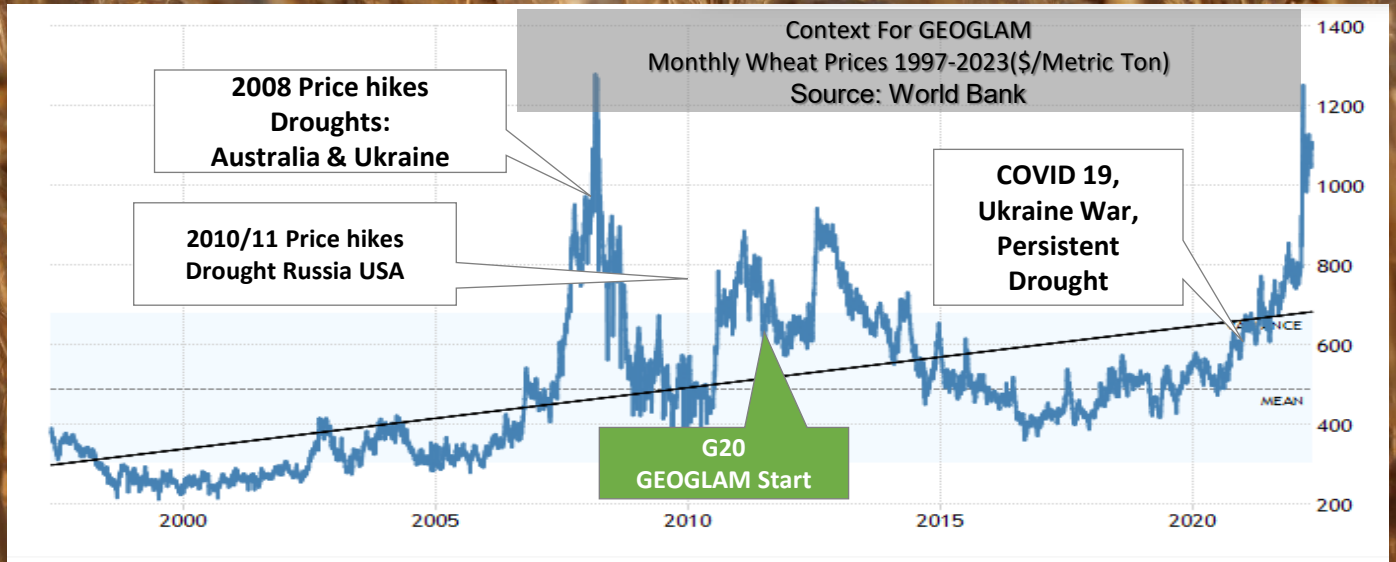
**G20 Final Declaration**

44. We commit to improve market information and transparency in order to make international markets for agricultural commodities more effective. To that end, we launched:

- The "Agricultural Market Information System" (AMIS) in Rome on September 15, 2011, to improve information on markets ...;
- The "Global Agricultural Geo-monitoring Initiative" (GEO-GLAM) in Geneva on September 22-23, 2011. This initiative will coordinate satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data.

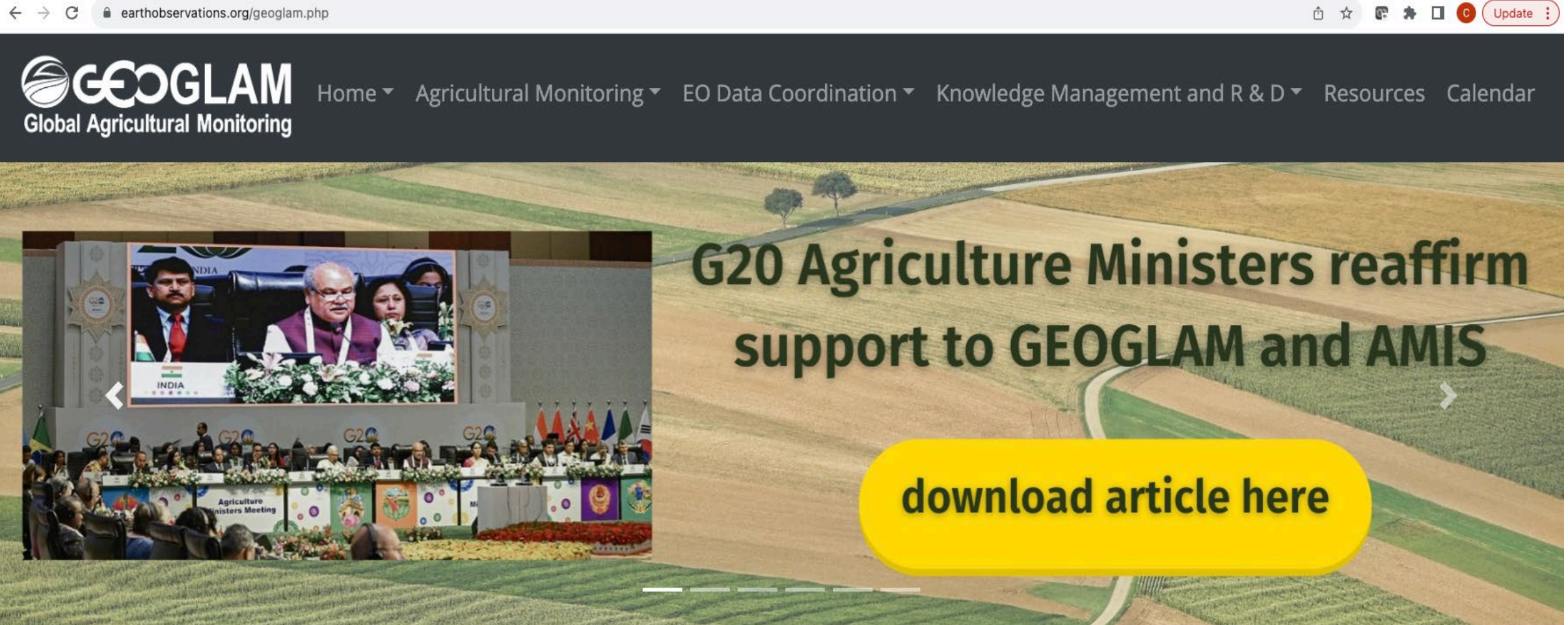
## Objective:

- To increase market transparency and improve food security by producing and disseminating relevant, timely, and actionable satellite-based information on agricultural conditions at national, regional, and global scales
- Support markets and informing early warning for proactive response to emerging food emergencies



# [GEOGLAM](#) is the Group on Earth Observations (GEO) Flagship Initiative focused on Agriculture and Food Security

2023 –The G20 under the Indian Presidency reaffirmed GEOGLAM’s contribution to Agriculture



The screenshot shows the GEOGLAM website interface. At the top left is the GEOGLAM logo with the tagline "Global Agricultural Monitoring". To the right of the logo is a navigation menu with items: Home, Agricultural Monitoring, EO Data Coordination, Knowledge Management and R & D, Resources, and Calendar. Below the navigation is a large banner image of a rural landscape with a road and fields. Overlaid on the left side of the banner is a photograph of a G20 Agriculture Ministers Meeting. The text "G20 Agriculture Ministers reaffirm support to GEOGLAM and AMIS" is displayed in large, bold, dark green letters across the center of the banner. A yellow rounded rectangular button with the text "download article here" is positioned in the lower right area of the banner. The browser's address bar at the top shows the URL "earthobservations.org/geoglam.php".

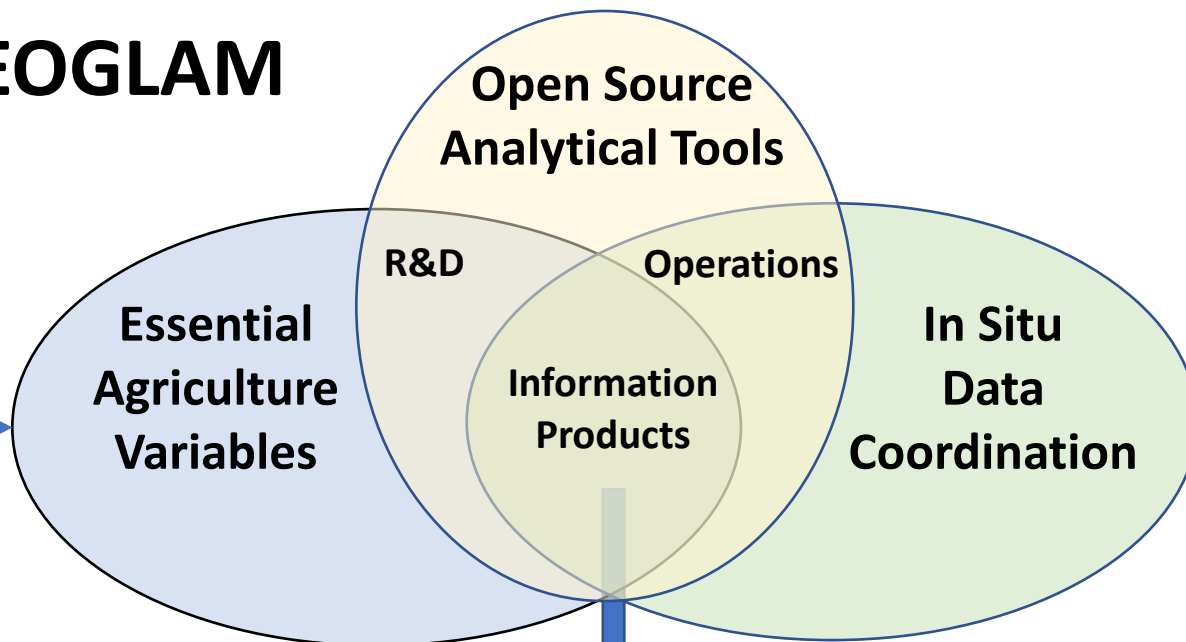
<https://earthobservations.org/geoglam/>



# GEOGLAM

- **Vision:** the use of coordinated, comprehensive and sustained Earth Observations to inform decisions and actions in agriculture... through a system of agricultural monitoring systems
- **Aim:** strengthen the international community's capacity to utilize Earth Observations to produce and disseminate relevant information on agricultural production at national, regional and global scales
- **Approach:** Identifying information gaps, building on existing monitoring systems – strengthening international and national capacity -
  - Emphasis on: producer countries (G20+), countries-at-risk and national capacity building
  - Fostering international cooperation and collaboration
- **A Forum for the Agricultural Monitoring Community of Practice**

# Current GEOGLAM Thematic Structure



## Ongoing Activities – Continue and Enhance:

- AMIS Crop Monitor
- CM4 Early Warning Crop Monitor
- GEOGLAM Knowledge Hub
- JECAM Joint Experiment

Needs

**Capacity (co) Development Guidance**  
(National and International)

**Capacity**

### Early Warning & Food Security

- Crop monitor for Early Warning
- Seasonal Forecasts
  - Special Reports

### Market Information

- Agricultural Markets Information System Crop Monitor
- Commodity Crop Conditions
  - Seasonal Forecasts

**Food Security**

### Adaptation

- National Adaptation Plans (NAP)  
UNFCCC Supplemental  
NAP Guidance

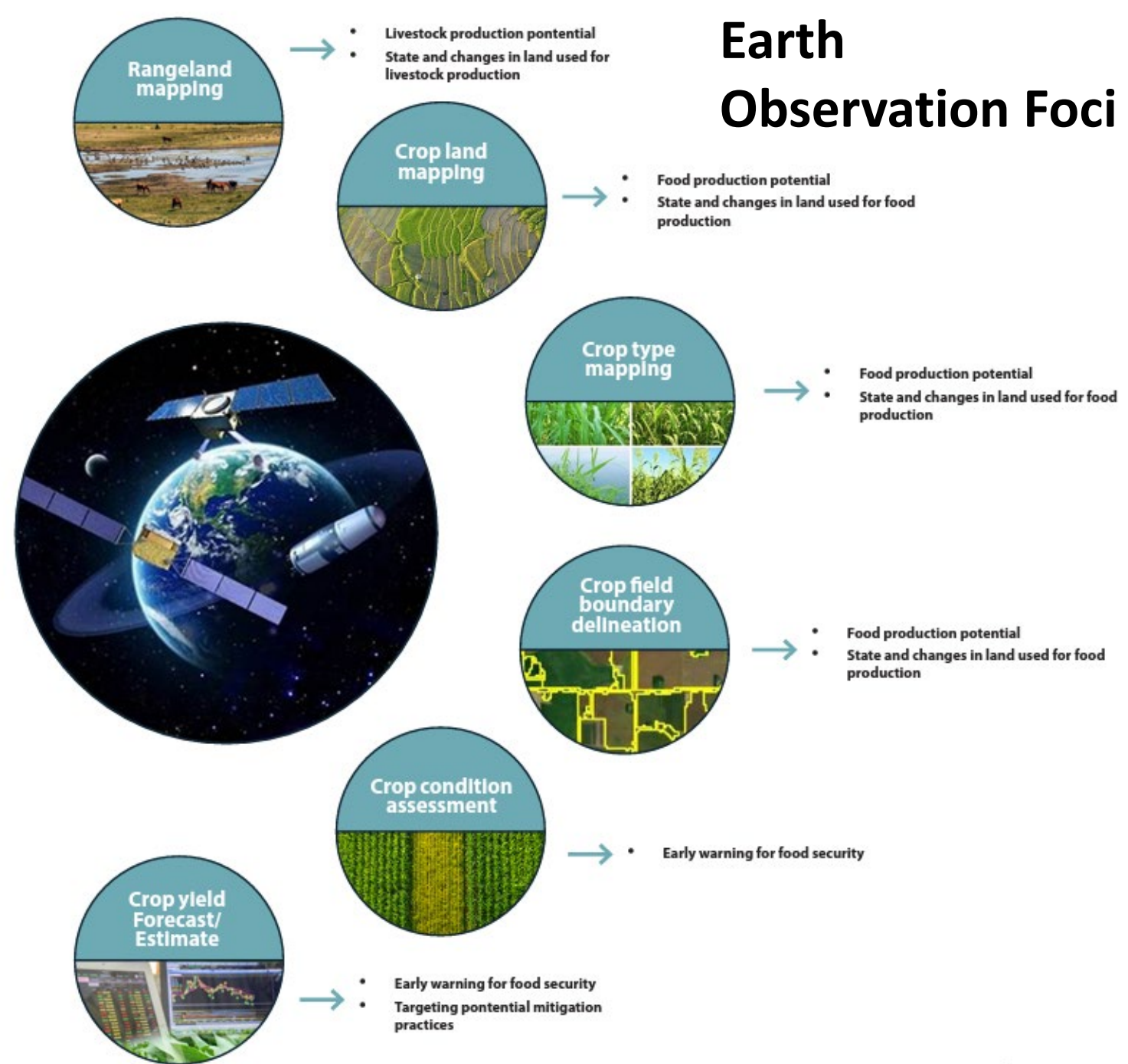
### Mitigation

- Global Stocktake (GST)  
Nationally Determined Contributions (NDCs)  
AFOLU Roadmap

**Climate**

# Monitoring and Measuring Agriculture Land Use & Trends Using Earth Observations

- Better information means better decisions across the value chain
- Improving information from the international to national and farm levels
- Driven by Open Science and Open Data



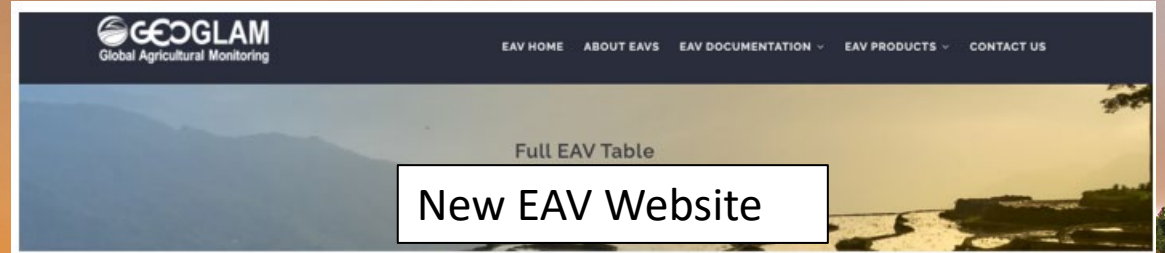
# GEOGLAM Initiative

## Essential Agricultural Variables

- Defining and Developing EAV's
- EO data needs
- In-situ data requirements
- Research gaps
- Operational requirements
- Satellite Data Products
- Product Accuracy Assessment

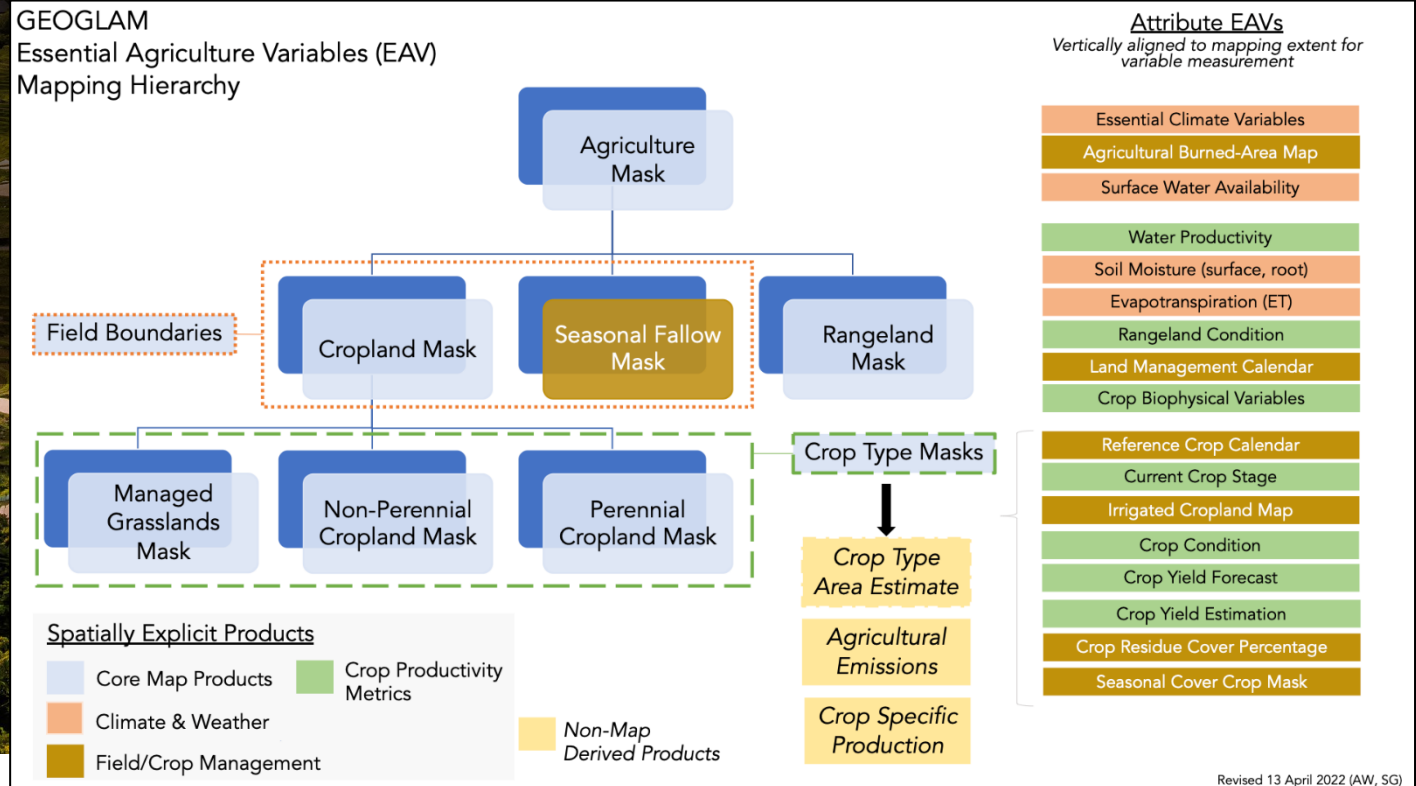
Providing input to the Space Agencies through CEOS

Identifying Good Practices for the Community of Practice



AgVariables.org

Definition	Agricultural Land Includes or is Indicated by	GEOGLAM Agriculture Indicator Category	Application or Policy Supported	Frequency of Update	Spatial Unit	Target Uncertainty	EAV Stewards	Requirements
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Revised 13 April 2022 (AW, SG)

.... as challenges mount  
**GEOGLAM** continues  
to evolve:



**Supporting policy priorities:**

- **Climate Change Adaptation and Mitigation**
- **Sustainable Development Goals**
- **Disaster Risk Reduction/Early Warning**



# Climate Action: National Adaptation Plans (NAPs) Earth Observations for Agriculture & Food Security

## Overview

- Guidance on the implementation of EO based early warning in less developed countries
- Identification of Essential EO Variables for Climate Action
- Institutional & Technical requirements for National Crop Monitoring
- To be used for developing national plans

In support of the UNFCCC National Adaptation Planning Process launched at COP27

## Integrating Earth Observations into the Formulation and Implementation of National Adaptation Plans: Agriculture and Food Security

GEO Supplement to the UNFCCC NAP Technical Guidelines



# GEOGLAM: the way forward

- Factors influencing international food insecurity can be expected to increase
  - Climate extremes
  - Pest and disease
  - Conflict
  - Nationally focused policy responses - to the above
- Earth Observation will play an ever increasing role to help inform policies and programs with an increasing number of space assets
  - Encouraging easy access to data and validated data products
  - Exploring how to establish partnerships with commercial data providers
- Key actions to rise to the challenge
  - Greater international cooperation and collaboration – funding mechanisms needed to enable that
  - Need to continue the evolution towards open data – Transparency, Innovation, Efficiency
  - Need for sustained operational solutions ensuring long term continuity
  - Scale up co-development efforts in less developed nations – Public Private Partnerships

# NASA HARVEST

NASA'S GLOBAL FOOD SECURITY AND AGRICULTURE CONSORTIUM



**Mission: to advance adoption of satellite Earth observations by public & private organizations to benefit food security, sustainability & agriculture, worldwide**

*Innovation is needed in developing robust & scalable measures to monitor the world's crops for addressing this global challenge.*

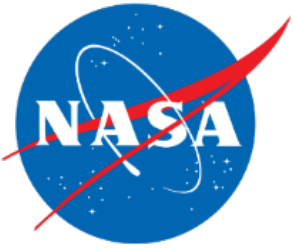
NASA Earth Action -  
<https://science.nasa.gov/earth/in-action/>

**HARVEST is NASA's Contribution to**



**Reaching our goals through strong & diverse partnerships**

For more info: [www.nasaharvest.org](http://www.nasaharvest.org)  
Follow us on Twitter: @HarvestProgram



# Harvest Impact Areas



A wholistic initiative-focused approach drives Consortium activities, partnerships, and outcomes.



Rapid Action for Agricultural Policy Support



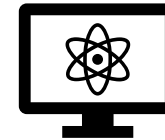
Markets, Trade and Supply Chains



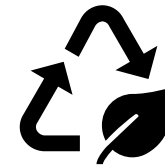
Regional Initiatives



Insurance & climate finance



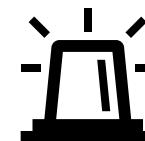
Artificial Intelligence & Machine Learning



Supporting Transition to Sustainable & Reg. Ag



Climate Risk Assessments






Early Warning for Early Action



# GLOBAL CROPLAND EXTENT & CHANGE 2000-2019



Global cropland extent  
change 2000-2019

-  Stable cropland
-  Cropland expansion
-  Cropland reduction

## nature food

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Article | [Open Access](#) | [Published: 23 December 2021](#)

**Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century**

[Peter Potapov](#), [Svetlana Turubanova](#), [Matthew C. Hansen](#), [Alexandra Tyukavina](#), [Viviana Zalles](#), [Ahmad Khan](#), [Xiao-Peng Song](#), [Amy Pickens](#), [Quan Shen](#) & [Jocelyn Cortez](#)

Global cropland expansion accelerated over the past two decades, most notably in Africa with Half the new cropland area (49%) replacing natural vegetation and tree cover.

In conflict with the sustainability goal of protecting terrestrial ecosystems.



# NASA/GEOGLAM CROP MONITOR INITIATIVE

Simple to understand for policy, markets, and early warning communities



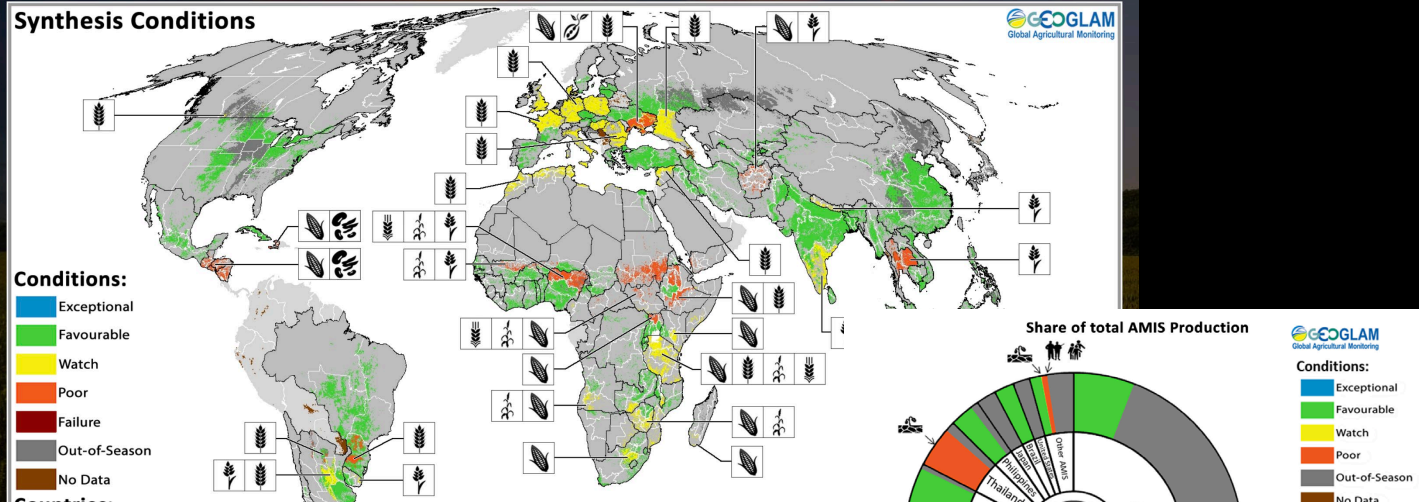
KARA MOBLEY



Brian Barker

Crop Condition Co-Lead

LATEST CONDITIONS PUBLISHED IN OUR REPORTS



Operational monthly consensus assessments on global crop condition based on time-series NASA satellite data, meteorological and partner ground information

## IMPACT

1. Used routinely in briefings by USAID Office of Food For Peace, European Commission (DG AGRI), UN FAO, World Food Program, and many governments to inform humanitarian aid and market decisions.
2. New partnership with UN Office for Coordination of Humanitarian Affairs (OCHA) to utilize Crop Monitor to trigger anticipatory action programs for food security.



Abdolreza Abbassian  
AMIS Secretary  
Senior Economist, FAO

*"Assessing the global supply situation and being able to predict unexpected shortfalls is the single most important task to guarantee global food security. At times of uncertainty, such as today, remote sensing information systems, such as the Crop Monitor, are critical for reducing uncertainty and enhancing market transparency."*

# NATIONALLY OWNED & OPERATED CROP MONITORS



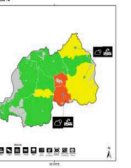
Catherine Nakalembe

Harvest Africa Lead

Source: The Crop Monitor

Map showing national performance for rice, maize and beans in November, based on several variables including remotely sensed data, rainfall, ground observations, and field reports.

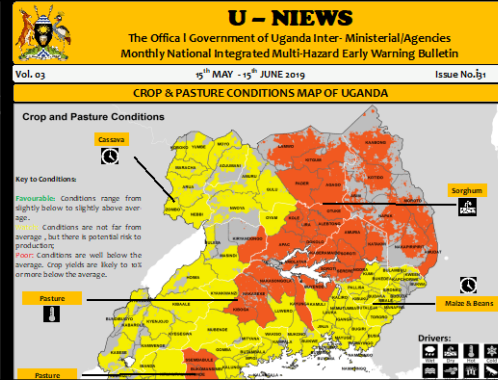
Socio-economic: In Kayunga district, Rice crop was affected due to insufficient water. The available water resources have been shared with the project that needs a lot of water for irrigation (KIWP), that competition is slowing down water supply in rice plantation and still rainfall amount in this season is very little.



Source: The Crop Monitor

Late rains that caused dry conditions affected Maize in Kicukiro, Gasho, Nyirugenge, Bugesera, Rwamagana, Nigoma, Kirehe, Nyagatare and Ruhango districts, during the germination and vegetative phases that unfavorable weather conditions lead to poor performance of maize crop.

Rwanda



U-NIEWS  
The Official Government of Uganda Inter-Ministerial/Agendes  
Monthly National Integrated Multi-Hazard Early Warning Bulletin

Vol. 03 15<sup>th</sup> MAY - 15<sup>th</sup> JUNE 2019 Issue No. 31

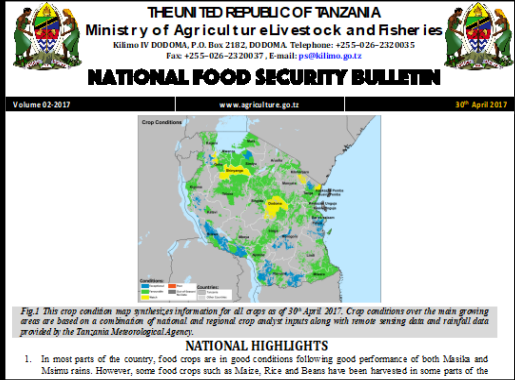
CROP & PASTURE CONDITIONS MAP OF UGANDA

**Crop and Pasture Conditions**

Key to Conditions:

- Favorable: Conditions range from slightly below to slightly above average.
- Marginal: Conditions are not far from average, but there is a potential risk to production.
- Poor: Conditions are well below the average. Crop yields are likely to be 20% or more below the average.
- Very Poor: Conditions are significantly below the average.

Drivers: Rain, Temperature, Soil Moisture, etc.



THE UNITED REPUBLIC OF TANZANIA  
Ministry of Agriculture, Livestock and Fisheries  
Kilimo IV DUKOMA, P.O. Box 21482, DODOMA, Tanzania. Telephone: +255-026-2320035  
Fax: +255-026-2320037, E-mail: pff@tanzania.go.tz

NATIONAL FOOD SECURITY BULLETIN

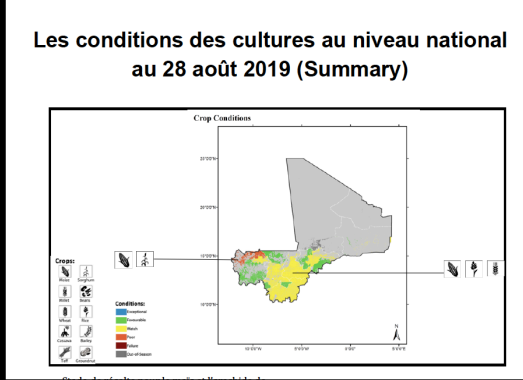
Volume 02-2017 www.agriculture.go.tz 30<sup>th</sup> April 2017

**Crop Conditions**

Fig. 1. This crop condition map synthesizes information for all crops as of 30<sup>th</sup> April 2017. Crop conditions over the main growing area are based on a combination of national and regional crop analysis inputs along with remote sensing data and rainfall data provided by the Tanzania Meteorological Agency.

**NATIONAL HIGHLIGHTS**

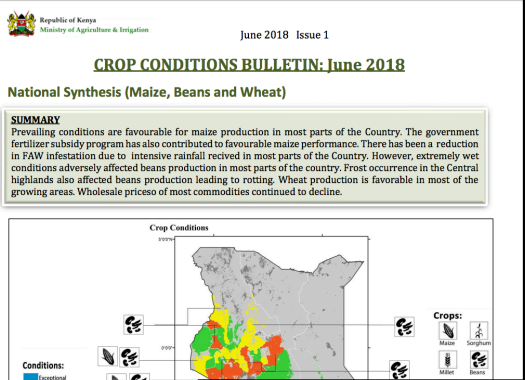
- In most parts of the country, food crops are in good conditions following good performance of both Masika and Misima rains. However, some food crops such as Maize, Rice and Beans have been harvested in some parts of the country.



Les conditions des cultures au niveau national  
au 28 août 2019 (Summary)

**Crop Conditions**

Legend: Favorable, Marginal, Poor, Very Poor.



Republic of Kenya  
Ministry of Agriculture & Irrigation  
June 2018 Issue 1  
CROP CONDITIONS BULLETIN: June 2018  
National Synthesis (Maize, Beans and Wheat)

**SUMMARY**  
Prevailing conditions are favourable for maize production in most parts of the Country. The government fertilizer subsidy program has also contributed to favourable maize performance. There has been a reduction in FAW infestation due to intensive rainfall received in most parts of the Country. However, extremely wet conditions adversely affected beans production in most parts of the country. Frost occurrence in the Central highlands also affected beans production leading to rotting. Wheat production is favorable in most of the growing areas. Wholesale prices of most commodities continued to decline.

- End-user Driven, National ownership, integrated into existing systems to meet national needs
- Enhancing regional and global information
- Standardized Global Approach for Crop Condition Monitoring

**Kenya**

OUTLOOK (Kenya Met Department (KMD) Development (SDCD))  
Good maize crop performance is expected to continue over most parts of Kenya. The expected enhanced rainfall in Western Highlands and parts of North Rift and Central highlands will lead to further improvement in crop performance in the region.  
Beans have been adversely affected in most parts of the country with localized flooding in many parts of the Central highlands.

Assessment by Crop: 4  
Climate outlook: 6  
Market information: 7  
Definitions: 10  
Partnerships: 10

**Mali**

les périmètres rizicoles de la région de Ségou, Mopti et de Tombouctou.  
Perspectives de productions jugées globalement moyennes à mauvaises dans le sabel occidental de la région.

Productions arboricoles moyennes à bonnes. Manguiers et les anacardiens en phase de déclin saisonnière de production.

**Tanzania**

average maize price while Mpanda, Mbeya, Kigoma Sumbungwa were all below average maize prices.  
10. Lowest maize price were observed in Mpanda, Mbeya and Kigoma market.  
11. High prices for maize were observed in Mpanda and Mwanza.  
12. High prices for maize were observed in Mwanza and Mpanda had the highest prices.

**Uganda**

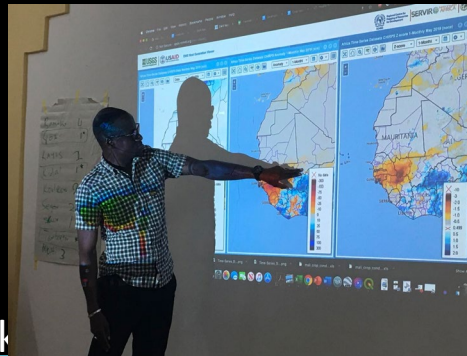
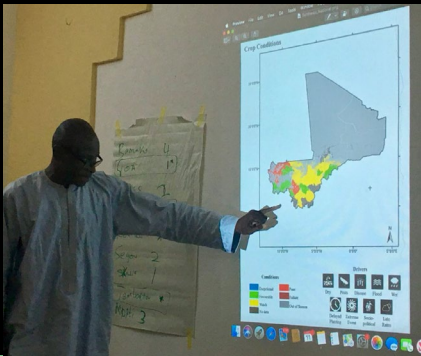
Medium to Long-term Strategies: 9  
Post Harvest Information: 10  
Public Awareness: 11  
Terms and Definitions: 12

may lead to improved pasture conditions.  
West Nile: The region is under "watch" crop conditions and planting is underway due to delayed onset of rainfall. Conditions are improving due to rainfall during the last decade of April 2019 leading to significant improvement in pasture conditions.  
These "Poor" crop and pasture conditions prevail across the region except for Kumi, Palim, Kibuku and Bulanda that are under "watch". The layout scattered and inconsistent below average rainfall accounts for the poor conditions. However if dry conditions persist, wide spread crop failure may occur.

Minister - Department of Relief, Disaster Preparedness and Management

**Rwanda**

Late rains that caused dry conditions affected Maize in Kicukiro, Gasho, Nyirugenge, Bugesera, Rwamagana, Nigoma, Kirehe, Nyagatare and Ruhango districts, during the germination and vegetative phases that unfavorable weather conditions lead to poor performance of maize crop.



Nak

# Agricultural Supply Chains

## and Food Security in the COVID-19 World



EARTH DATA FOR INFORMED AGRICULTURAL DECISIONS

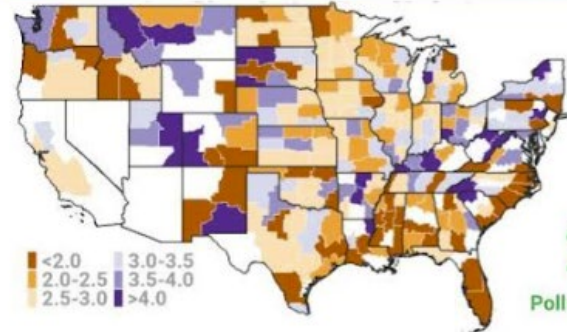


### Weather Patterns Poll - USA

Do you agree? My local weather patterns are more extreme vs. 5-years ago. Respond 1=strongly disagree to 5=strongly agree.

1,734 Farms

29-Nov-2022



2.8

Poll Avg Rating

State	Avg Rating	Responses	State	Avg Rating	Responses
West Virginia	5.0	2	Colorado	2.8	48
Utah	3.8	6	Nebraska	2.7	142
Maryland	3.8	5	Michigan	2.7	60
Kentucky	3.7	14	North Dakota	2.6	92
Louisiana	3.5	15	Idaho	2.6	14
Ohio	3.4	79	Tennessee	2.6	24
Montana	3.4	31	South Carolina	2.6	5
New York	3.3	18	Minnesota	2.6	158
Washington	3.3	18	Oregon	2.6	8
Arkansas	3.2	37	Iowa	2.6	152
California	3.1	12	Oklahoma	2.6	29
South Dakota	3.0	87	Georgia	2.5	13
New Jersey	3.0	2	North Carolina	2.5	16
Kansas	2.9	112	Wyoming	2.5	2
Missouri	2.9	71	Virginia	2.3	9
Wisconsin	2.9	74	Alabama	2.1	14
Indiana	2.9	103	New Mexico	2.0	4
Illinois	2.8	118	Mississippi	1.9	20
Pennsylvania	2.8	37	Florida	1.7	6
Texas	2.8	77	Connecticut	1.0	1

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### Price Transmission and Farmer Outreach with FBN

### Global Wheat Crop Conditions: 2022

#### Percent Crop Condition of Active Crops



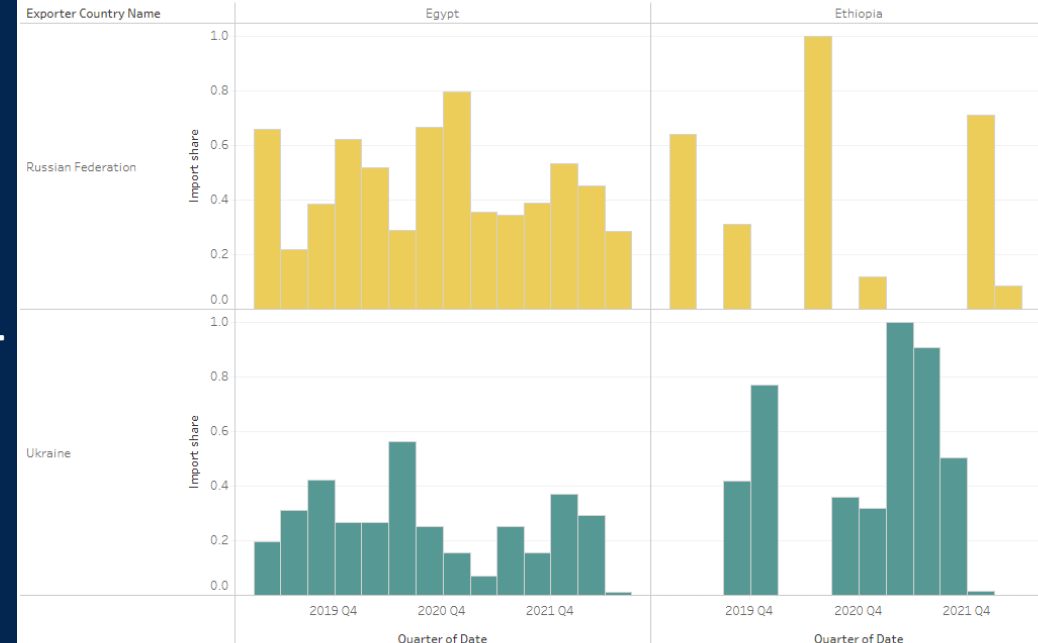
#### Crop Calendars of the Top Producers

Top Producers	% of Global Production*	January	February	March	April	May	June	July	August	September	October	November	December
China: Winter (95%)	38												
Spring (5%)													
European Union	17												
India	14												
Russian Federation: Winter (65%)	10												
Spring (35%)													
United States: Winter (71%)	6												
Spring (29%)													
Canada: Spring (89%)	4												
Winter (11%)													
Australia	4												
Ukraine	4												
Pakistan	3												
Argentina	3												
Türkiye	2												
Iran	2												
United Kingdom	2												
Kazakhstan	2												

\* Based upon the 5 year average (2018-2022)

Planting - Early Vegetative Vegetative - Reproductive Ripening through Harvest Harvest (End-of-Season)

### Historical change of Food trade dependence index (country to country import share) by source country



Exporter Country Name

Russian Federa... Ukraine

IFPRI Collaboration Kim, Tokgoz, Glauber, Puricelli, Humber et al.



# Russian Invasion of Ukraine

February 24, 2022

*Raised concerns about Global Food Security*

The Economist

Inside the Putin show

What next for SoftBank?

Graphene and decarbonisation

Is China uninvestible?

MAY 21ST - 27TH 2022

## The coming food catastrophe



### Ukraine war 'catastrophic for global food'

7 March · Comments

Russia-Ukraine war



By Emma Simpson  
Business correspondent, BBC News

The war in Ukraine will deliver a shock to the global supply and cost of food, the boss of one of the world's biggest fertiliser companies has said.

### Forty Percent of the World Food Program's Wheat Supplies Come from Ukraine

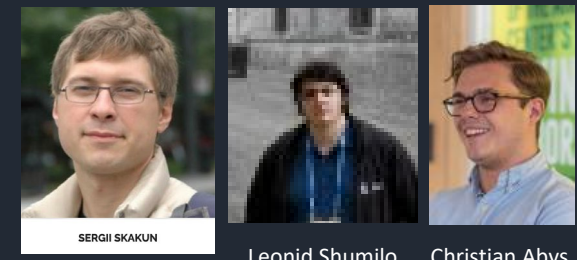
By Ambassador Mark Green on June 2, 2022

FOOD AND AGRICULTURE UKRAINE



# NASA MONITORING OF AGRICULTURE FOR UKRAINE

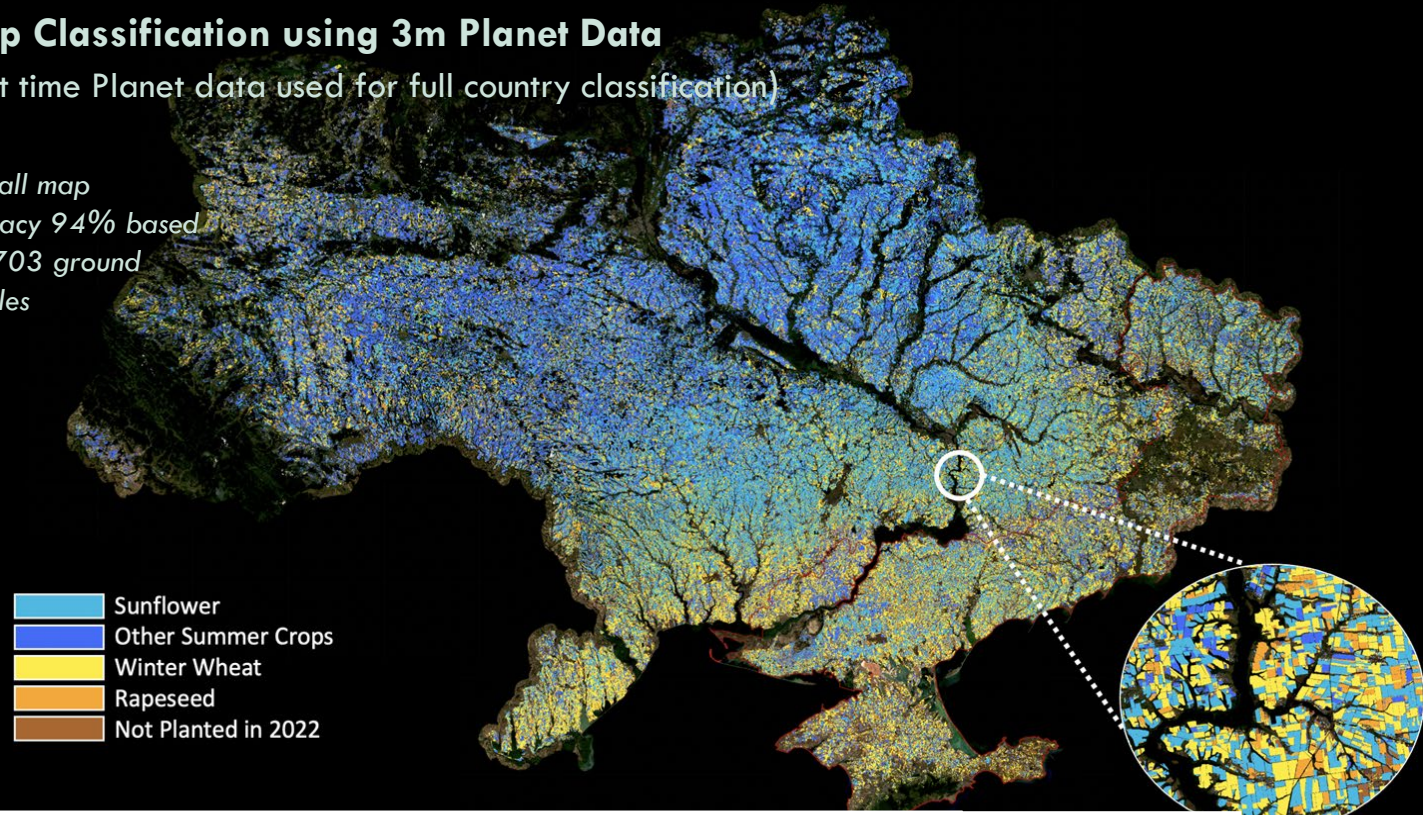
- In partnership of the Ukraine Ministry of Agriculture



## Crop Classification using 3m Planet Data

(First time Planet data used for full country classification)

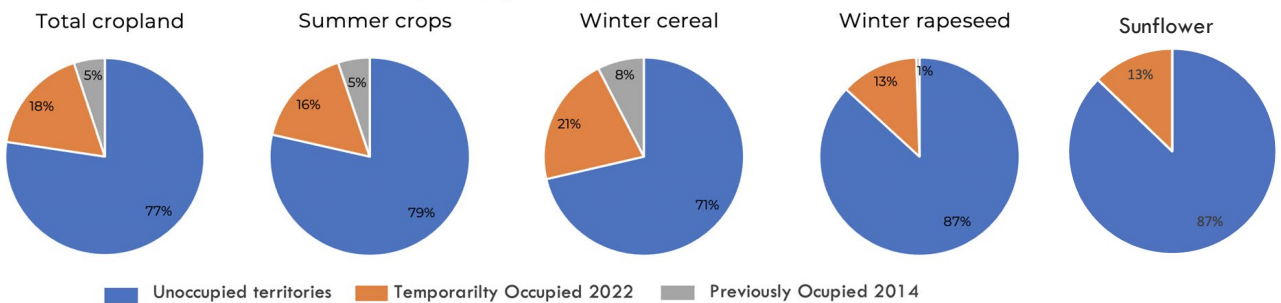
Overall map accuracy 94% based on 4703 ground samples



- Sunflower
- Other Summer Crops
- Winter Wheat
- Rapeseed
- Not Planted in 2022

## Ukraine Crop Proportions By Occupation Status

(As of July 11, 2022)



## NASA Harvest Wheat 2022 Estimates

Territory	Production	Yield	Area harvested	Area Planted
All Ukraine	26.6	3.98	6.74	7.20
Ukraine Controlled	20.8	4.08	5.14	5.40
total occupied	5.8	3.66	1.60	1.80

In 2022 ~22% of Ukraine's wheat was harvested in occupied territories. Translating to > \$1.3 billion of loss to Ukraine in 2022.

## NASA Harvest Wheat Estimates 2023

Territory	Area (M Ha)	Production (MMT)	Yield (T/Ha)
All of Ukraine	6.37	29.16	4.58
Ukraine Controlled Territories	4.78	23.07	4.83
Russian Temporarily Occupied	1.60	6.09	3.81

2023: higher production, owing to higher yields. Decline in planted area. Significant area of abandoned land along the front line.

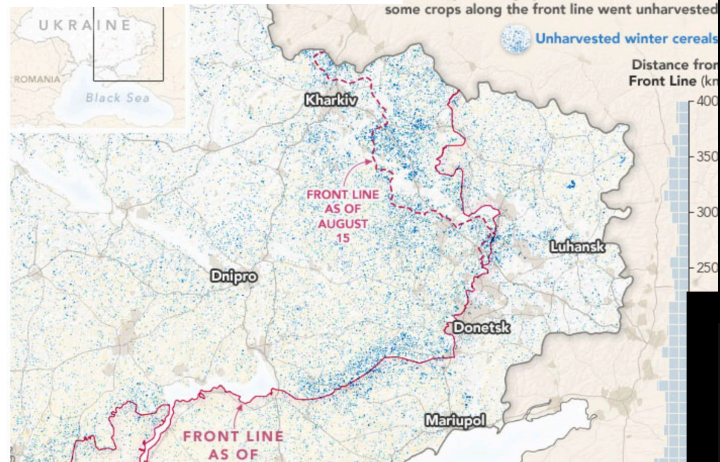
NASA Harvest is prototyping and providing production estimates over the Russian occupied territories.





# Harvest in Ukraine

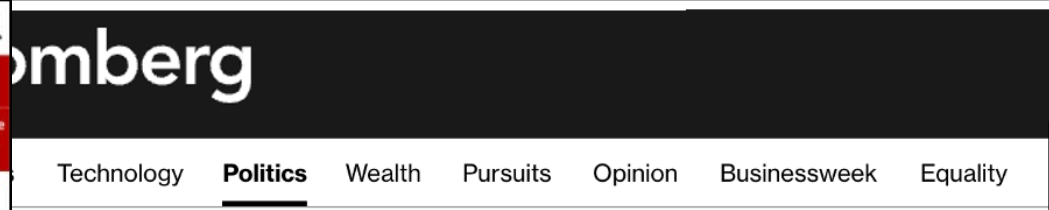
NASA Harvest Director  
NASA Harvest Consortium Manager



# Ukraine dam: Satellite images reveal Kakhovka canals drying up

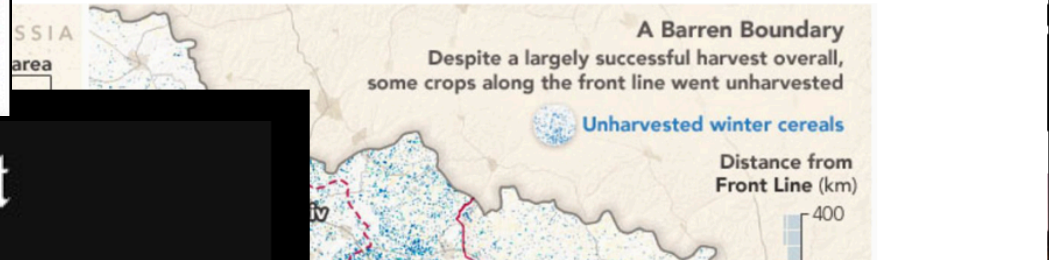
22 June

Russia-Ukraine war



# Ukraine Reaped \$1 Billion of Wheat in Occupied Ukraine, NASA Says

NASA Harvest uses satellite imagery to model wheat crop in occupied Ukraine. Harvest of Ukraine wheat is grown on land claimed by Russia.



9:40 a.m.

# Russia now controls about 22% of Ukraine's arable land, NASA says

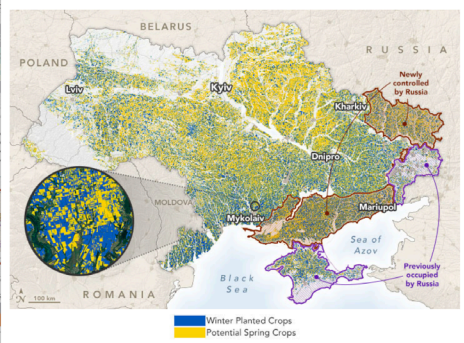
By Annabelle Timsit



Russia now occupies roughly 22 percent of Ukraine's farmland, according to a NASA analysis.



# Measuring War's Effect on a Global Breadbasket



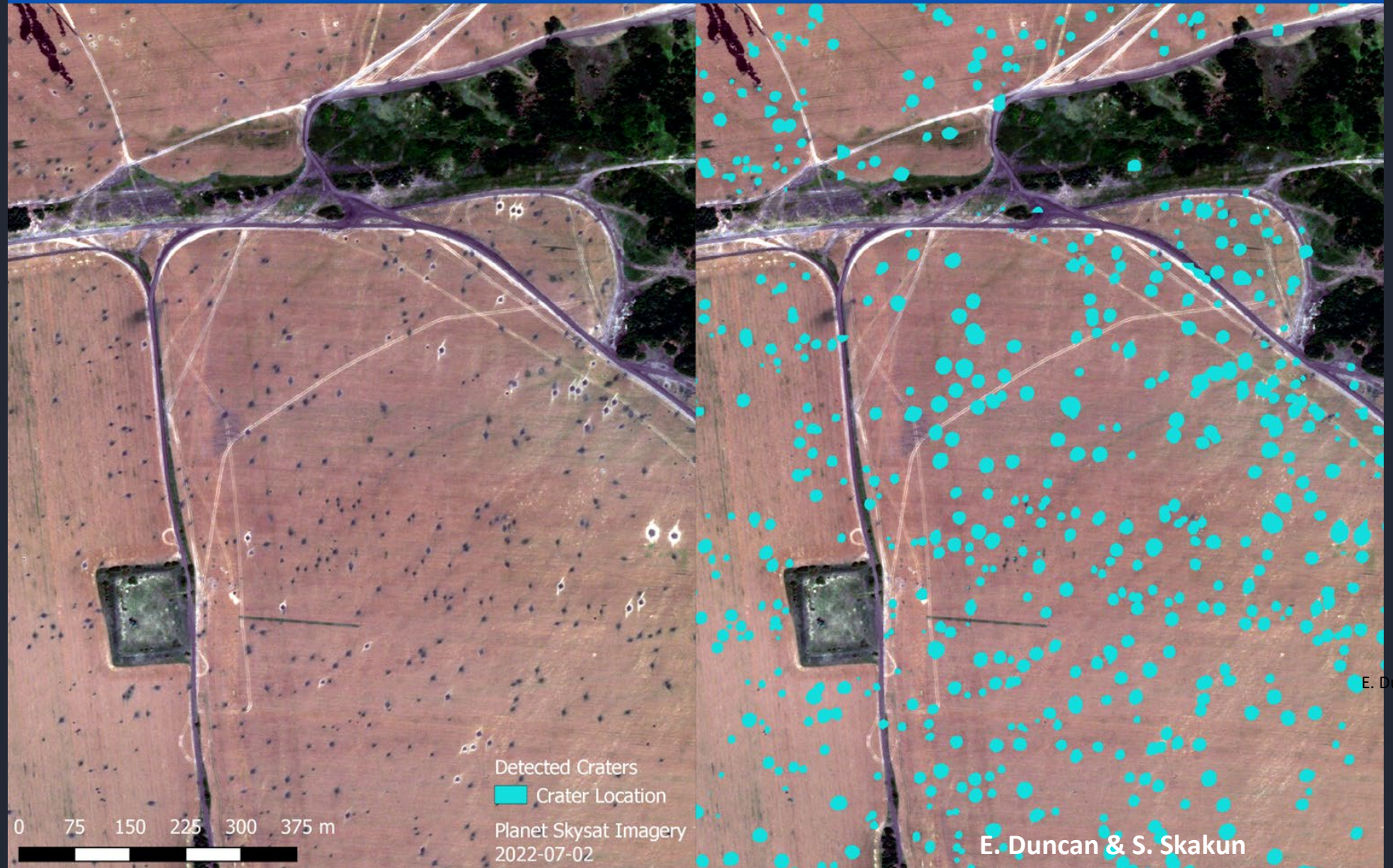
NASA Harvest researchers are using satellite observations and economic data to track how the Russia-Ukraine conflict is disrupting the global food system.

Image of the Day for July 1, 2022

Instruments:  
In situ Measurement  
Landsat 8 — OLI  
Photograph  
Planet Labs — Cubesat

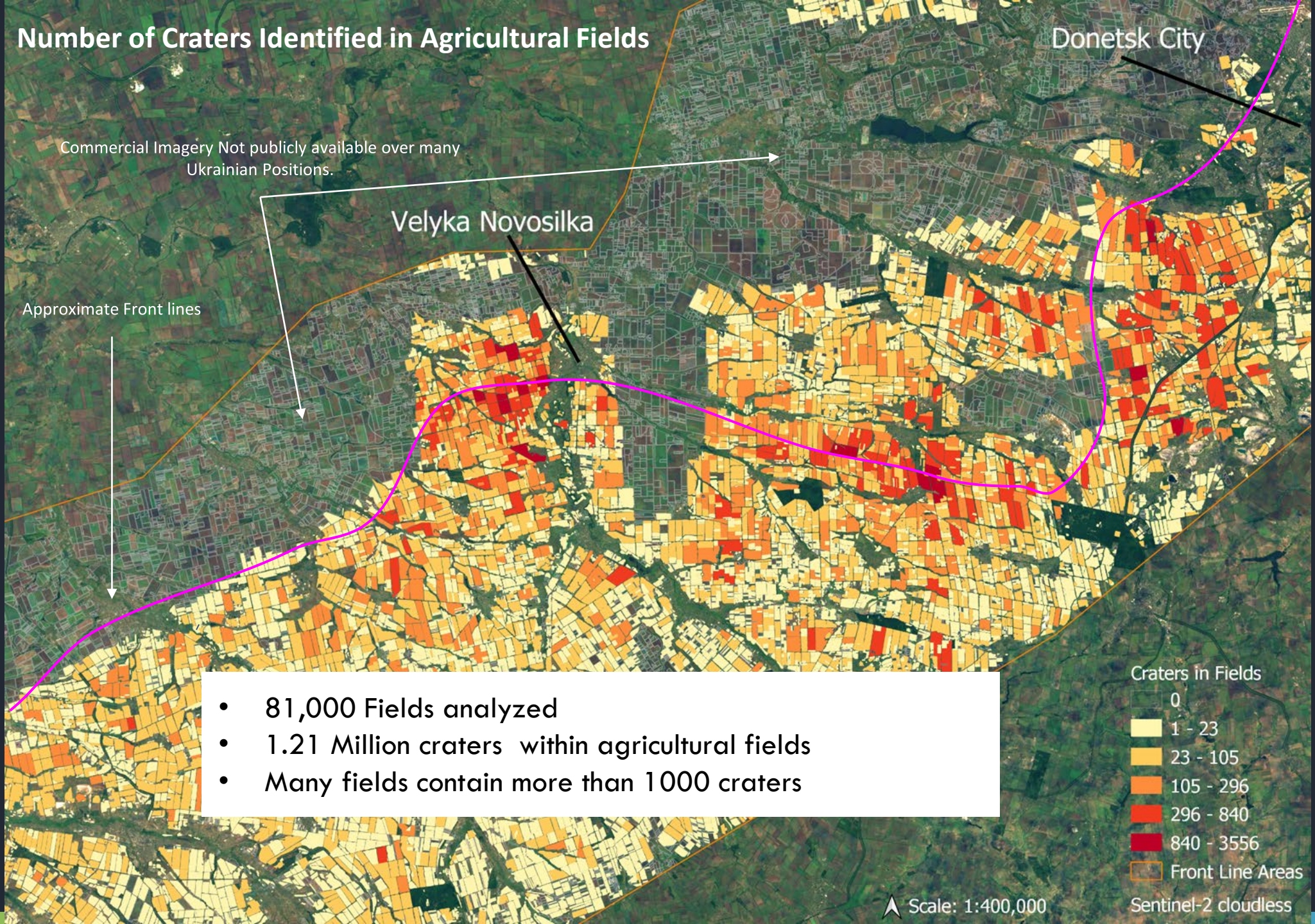
# Very High Resolution Data for Agricultural Damage Assessments

## Crater Detection in Planet Skysat Imagery



E. Duncan

# Number of Craters Identified in Agricultural Fields



# Ukraine Dec 2023 Assessment



....the 2023 season did see an increase in yields and production relative to 2022 for both wheat and sunflower, two of the major export crops in Ukraine. However, a significant portion of this production was harvested in Russian-occupied territories. Dr. Inbal Becker-Reshef, NASA Harvest Director explains, "to put this in perspective, the amount of wheat alone harvested in the Russian-occupied territories in 2023, 6.42 mMT, is higher than what was harvested in the State of Kansas in 2023, the second largest wheat producing state in the US, or the equivalent of roughly 55% of Egypt's total wheat imports, the largest global wheat importer."



*Satellite imagery reveals that approximately 7% of Ukraine's total cropland has been abandoned in 2023 due to the war, translating to \$2 billion in lost harvest and a quantity of grains and oilseeds that could have fed over 25 million people for a year.*

<https://nasaharvest.org/news/farming-amidst-war-satellite-data-reveals-productive-yet-challenging-season-ukraine>

# MALAWI CYCLONE FREDDY AGRICULTURE IMPACT ASSESSMENT

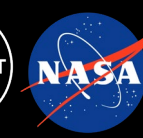
*A rapid response facility demonstration*

April 2023 rapid crop condition survey was **updated in 1 week with flood impact questions** and used to assess the impact of Cyclone Freddy on agriculture and food security in Southern Malawi in partnership with Ministry of Agriculture and UN FAO

**Over 2000 fields surveyed in 5 days** to assess the flood impact on agriculture and summarize impacts at EPA level

Data were **automatically analyzed** through the online tools and **available immediately** to feed into reporting mechanisms

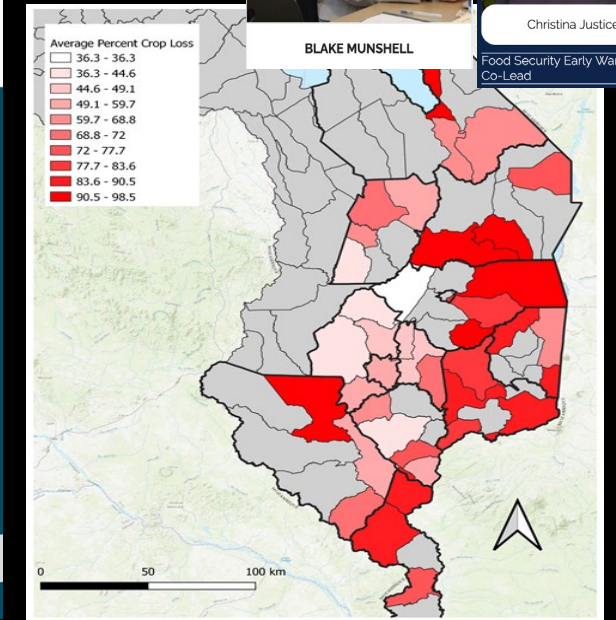
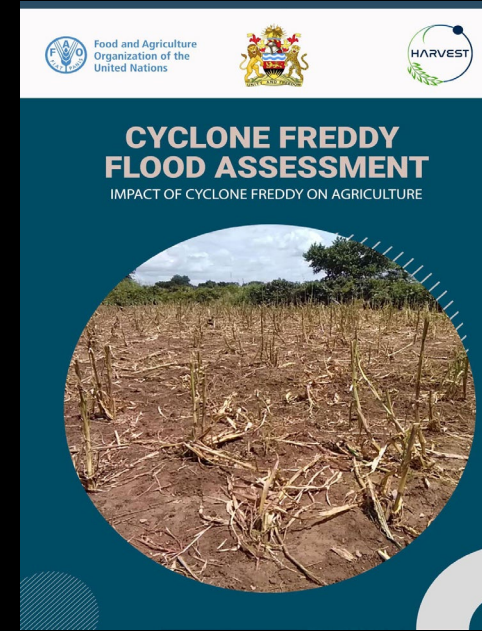
Results were used to support the Ministry's flood impacts assessment



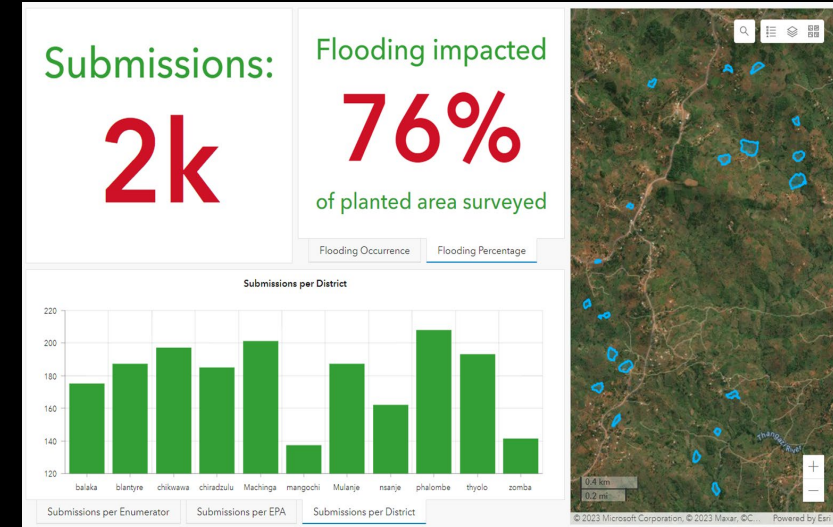
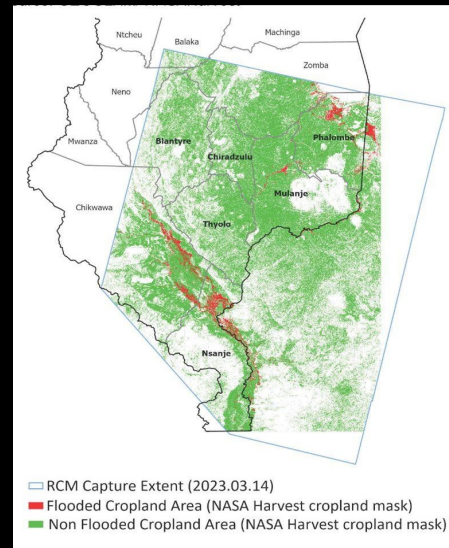
BLAKE MUNSELL

Christina Justice

Food Security Early Warning Co-Lead



Flooding damaged 76% of crop area surveyed and 72.7% of total crop loss was reported.



\*Supported by funding from USAID



# DEVELOPING A FACILITY FOR RAPID AGRICULTURAL ASSESSMENTS FOR POLICY SUPPORT



Inbal Becker-Reshef

NASA Harvest Director