

Essential Agriculture Variables for GEOGLAM: Status and Priorities for Implementation

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With thanks to:

Sven Gilliams, VITO

Andrew Davidson, Andrew Nelson, Belen Franch, Benjamin Koetz, Bettina Baruth, Bimal Bhattacharya, Catherine Champagne, Chris Justice, Felix Rembold, Greg Husak, Heather McNairn, Hongwei Zeng, Ian Jarvis, Inbal Becker-Reshef, Indrani Kommareddy, Jinlong Fan, Jippe Hoogeveen, Joanne Hall, Juan Guerschman, Keelin Haynes, Leonid Shumilo, Mario Zappacosta, Miao Zhang, Michel Massart, Mykola Lavreniuk, Nataliia Kussul, Pierre Defourny, Rogerio Bonifacio, Sophie Bontemps

GEOGLAM's Growing Policy Mandate(s)

GEOGLAM and the G20

- The G20 has expanded their original focus beyond markets to additionally include
 - “food security”
 - Supporting “coordinated policy responses”

Strengthening linkages to:

National & Global policy frameworks, including:

UN 2030 Agenda for Sustainable Development (SDGs)

Sendai Framework for Disaster Risk Reduction

UNFCCC – Paris Climate Accords

UN Land Degradation Neutrality

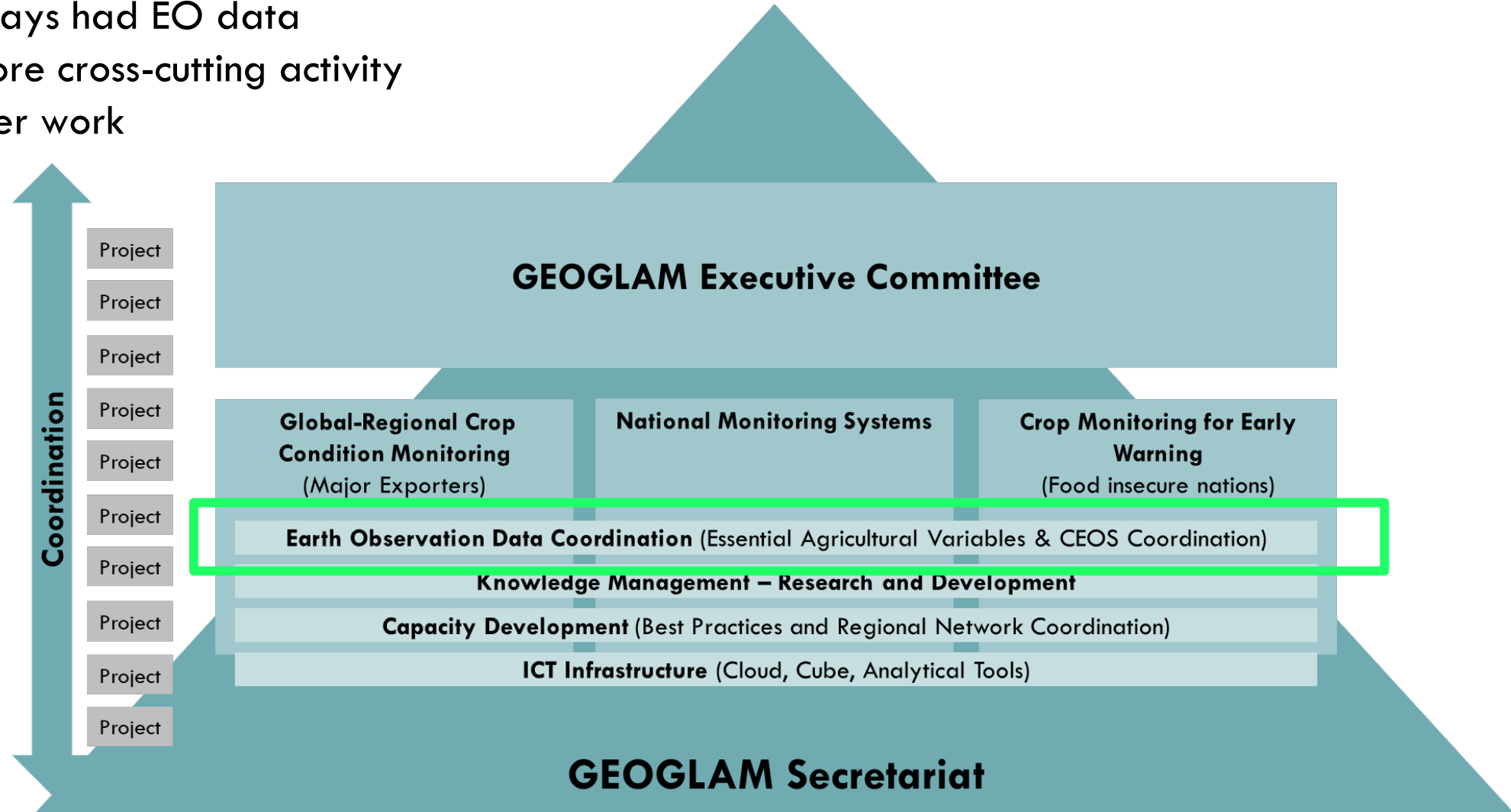
National Adaptation Planning



Whitcraft et al., 2022, AGU Books

And so the program has expanded

GEOGLAM has always had EO data coordination as a core cross-cutting activity that enables all other work



GEOGLAM Earth Observation Data Requirements Table (2019)

			Spatial Res	100 - 1000 m	50-500 m	5-25 km	30-100m	10-30m	10-30m	10-30m	10-30m	5-10m	5-10m	< 5m	< 5m	< 3m	<30m	
			Spectral Range	optical	optical	passive microwave	thermal	VIS NIR + Red Edge + SWIR	SAR dual polarization	SAR coherence	SAR Multifrequency	VIS NIR + Red Edge + SWIR	SAR dual polarization	VIS NIR	VIS NIR	VIS NIR	SAR Multifrequency	
			Cloud Free Obs Frequency	Twice daily	2-5 per week	Daily	2 to 7 per week	Weekly	2-4 per week	2-4 per week	Weekly	Weekly	2-4 per week	3/year (2 in + 1 out of season)	1 to 2 per 3 years	1 to 2 per month	Weekly	
			Extent of Obs	Wall-to-Wall	Cropland extent	Wall-to-Wall	Cropland extent	Cropland Extent	Cropland extent	Cropland extent	Cropland extent	Cropland Extent	Cropland extent (cloudy & rice)	Cropland extent every 3 years	Cropland extent	Refined Sample of All Fields	Cropland extent (cloudy)	
Core Information Products and Essential Agricultural Variables for GEOGLAM	Within Season Crop Mask	Monthly			X			X	X	X	X	X	M/S	S		S		
	Within Season Crop Type Mask	Monthly			X		X	X	X	X	X	X	M/S	S		S		
	Crop (Type) Area Indicator	Mid Season						M/L	M/L	M/L	M/L	X	X	M/S		X		
	Crop Condition Indicators	Weekly		X	X	X	X	X				X						
	Current Crop Phenology & Ag Practices	Weekly			L			X	X	X	X	X	M/S				X	
	Biomass, LAI, fAPAR, fCover, NDVI, Height	2-3 days		L	L	X	X	X	X	X	X	X	X					X
	Within Season Yield Forecast	Monthly		L	L	X	X	X	X	X	X	X				X		
	End of Season Yield Estimation	End of Season		L	L	X	X	X	X	X	X	X				X		
	Soil Moisture	Daily				X	X		X	X	X		X					X
	ET, Water Use, Water Productivity LST	Daily			X	X	X	X	X	X	X		X	X				
	Usual Crop Calendars	Every 5 years		L	L				X	X	X	X						
Field delineation	Every 3 years							L	L	L		L		M/S	M/S	M/S		

- When looking across the GEOGLAM program, we discovered inconsistent definitions of what our priority variables were
- Requirements Table listed general variables with update frequency
 - Provided spatial, spectral, temporal, extent requirements
 - Lacking product information or prioritization
- Lacking info that tied them to policy, use, or application
 - And how they related to, fed into, or were derived from one another

	EAVs	Req Table	Research Agenda
Ag land cover/use	as supporting ECV		x
Ag land cover/use change			x
Within Season Crop Mask	x	x	as ag land cover
Within Season Crop Type Mask	x	x	x
Crop (Type) Area Indicator	x	x	x
Crop Condition Indicators	x	x	x
Current Crop Phenology	x	x	
Ag Practices		x	as crop cycles, crop rotation, fallow mapping, tillage mapping
Biomass	x	x	
LAI	x	x	
fAPAR	x	x	
fCover	x	x	
NDVI	x	x	
Height		x	
Within Season Yield Forecast	x	x	
End of Season Yield Estimation	x	x	
Soil Moisture	supporting	x	x
ET	supporting	x	x
Water Use		x	
Water Productivity		x	x
LST	supporting	x	
Usual Crop Calendars	supporting	x	
Field delineation	x	x	
drought risk			x
drought impact			x
irrigated area	x		x
Nitrogen content est			x
pasture mapping	x		
rangeland productivity & quality	as rangeland and pasture condition assessment		x
crop disease			x

For a complex policy and operations environment, we need an integrator



- Policy/decision support drive the data requirements
 - Space agencies need traceability to justify missions & science teams
- Data needs to be transformed in order to be useful to policy
 - We need to reduce complexity
- GEOGLAM provides a bridge to connect Earth observations to impact (*two-way connection*)
 - Variable specification
 - Feedback to space agencies
 - Product generation
 - Standard products
 - Methods improvement
 - Cal/val, in situ data
 - Capacity Development
 - Operational transition

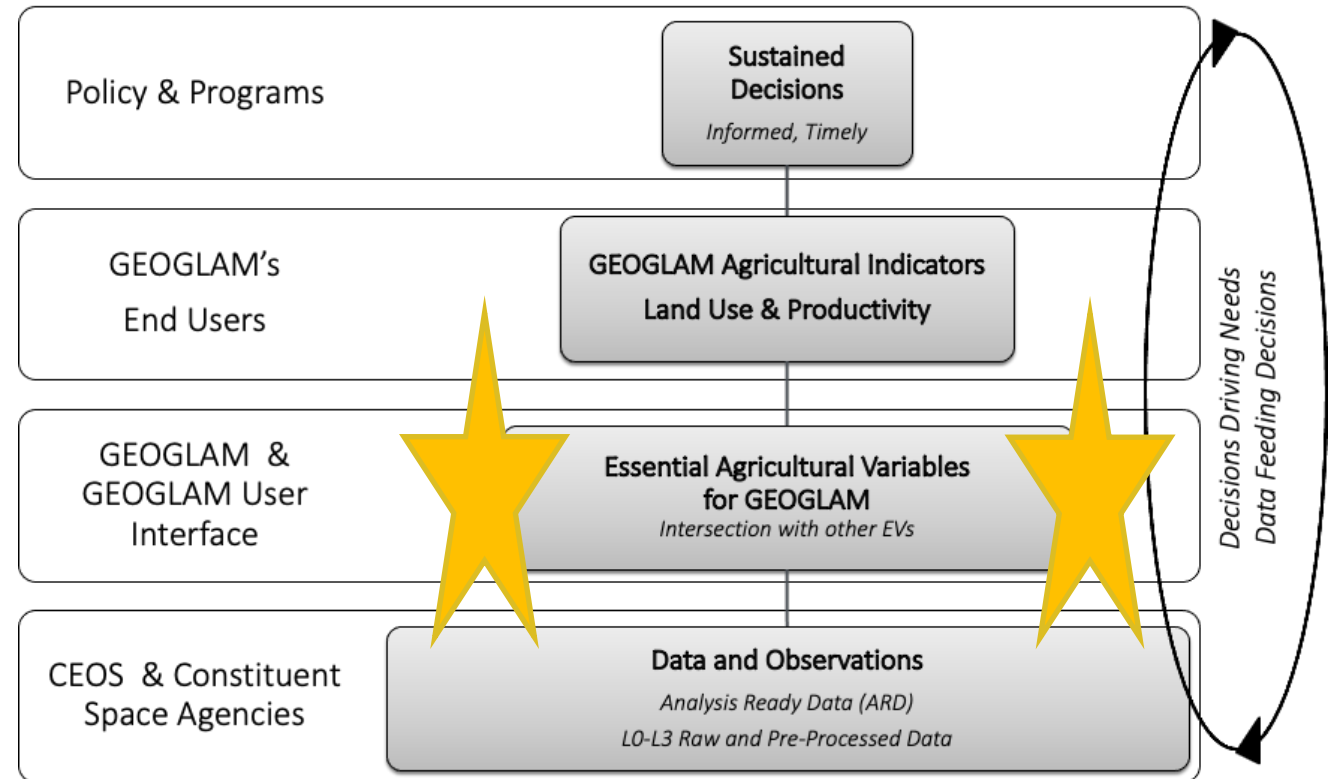
EAVs as Integrators

Information produced by the GEOGLAM community can help support a multitude of policy targets

Building upon other EVs allows inter-policy relevance

- Policy targets require information integrated across multiple science communities
- “once the geospatial data are created, they can be used many times to support a multiplicity of applications” – UN

It also integrates the data-to-decisions cycle →



GEOGLAM's Essential Agricultural Variables

Co-leads: Whitcraft (UMD/NASA Harvest) & Gilliams (VITO)

- **Essential:** key 'building blocks' to produce relevant and timely information products
- **Agriculture:** related to agricultural productivity and land use
- **Variables:** they can be measured or inferred, and change over space and time
- **For GEOGLAM:**
 - Using satellite Earth observations
 - Meeting our policy mandates

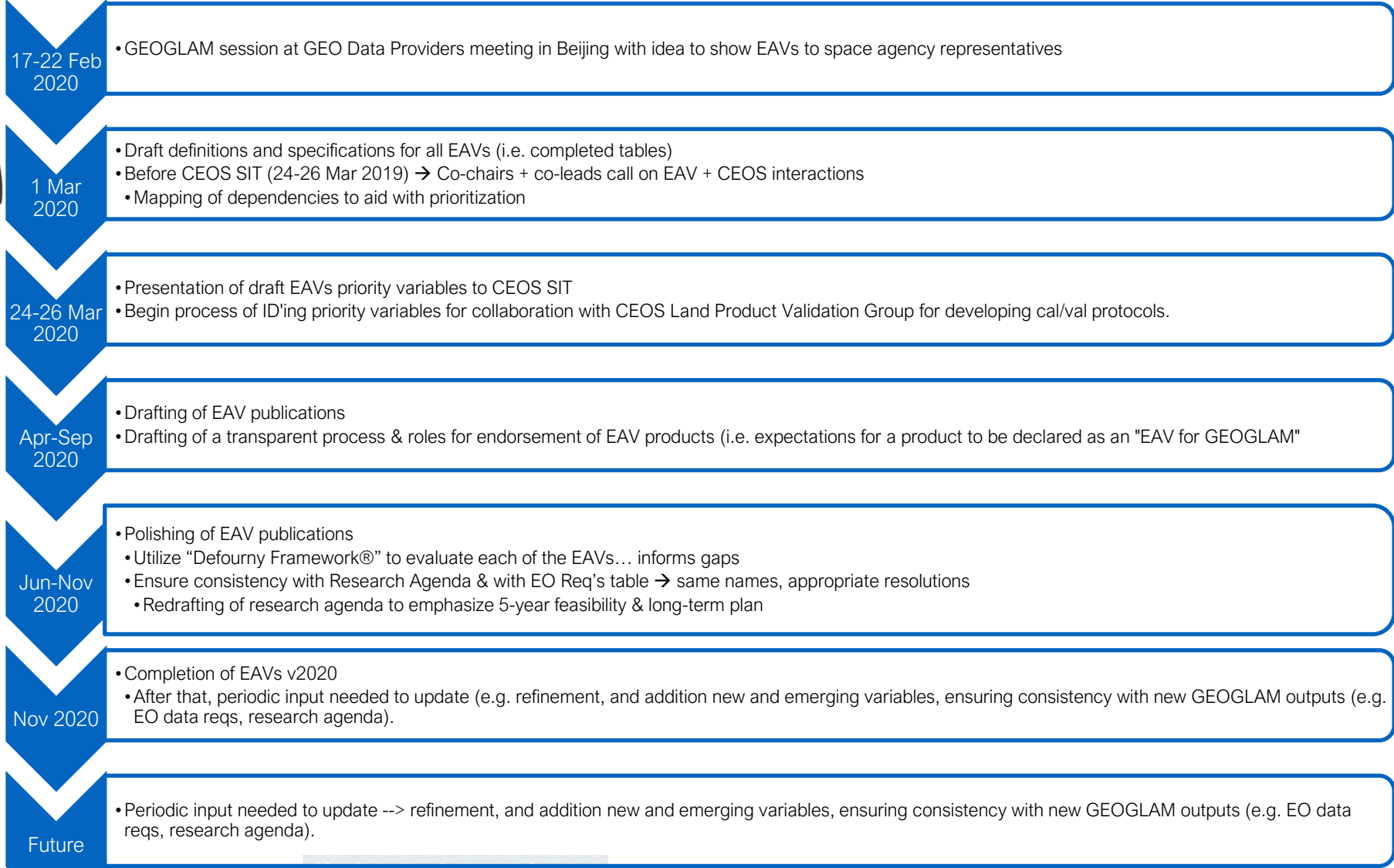
Not intended for farm-level decision support – although methods developed are often transferable



First Meeting of the GEOGLAM EAV Working Group
23-24 October 2019 | UCL

EAVs: A Process

Original Timeline
est. Nov 2019



How it Started...



How it Went...

The screenshot shows a Zoom meeting in progress. The main area is a grid of 20 video thumbnails. The bottom row contains three thumbnails with large circular icons: 'D' (Davidson), 'M' (Michel Massart), and 'ML' (Mykola Lavreniuk). The right sidebar shows a list of 20 participants with their initials and names. The bottom of the screen features the Geoglam logo and the text 'Living Planet Symposium 2022 23-27 May'.

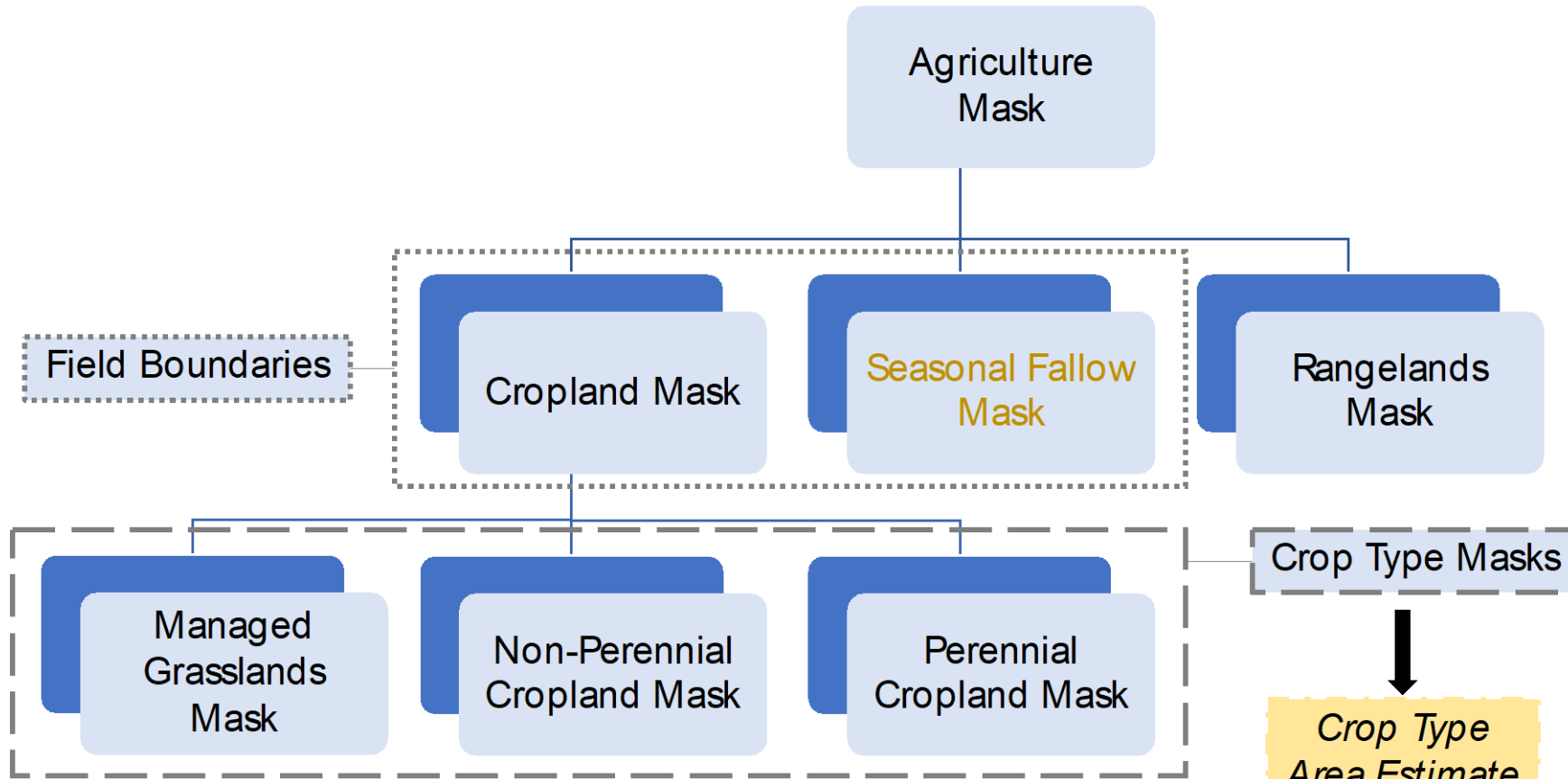
Participants (20)

- AYW Ayssa Whitcraft (Host, me, internal)
- AN Andy Nelson
- BF Belen Franch (Internal)
- BK Benjamin Koetz
- BB Bettina BARUTH
- BB Bimal Kumar Bhattacharya
- CC Catherine Champagne
- D davidson
- I Ian Jarvis
- IB Inbal Becker-Reshef (Internal)
- J Jippe
- JG Juan Guerschman
- MZ Mario Zappacosta
- MM Michel Massart
- ML Mykola Lavreniuk
- N Natalia
- PD Pierre Defourny
- S shumi
- SB Sophie Bontemps
- SG sven gilliams

GEOGLAM
Essential Agriculture Variables (EAV)
Mapping Hierarchy

How it's Going...

Attribute EAVs
Vertically aligned to mapping extent for variable measurement



- Essential Climate Variables
- Surface Water Availability
- Agricultural Burning

- Water Productivity
- Soil Moisture (surface, root)
- Evapotranspiration (ET)
- Rangeland Condition
- Land Management Calendar
- Crop Biophysical Variables

- Reference Crop Calendar
- Current Crop Stage
- Irrigated Cropland Map
- Crop Condition
- Crop Yield Forecast
- Crop Yield Estimation
- Crop Residue Cover Percentage
- Seasonal Cover Crop Mask
- Tillage Intensity

Spatially Explicit Products

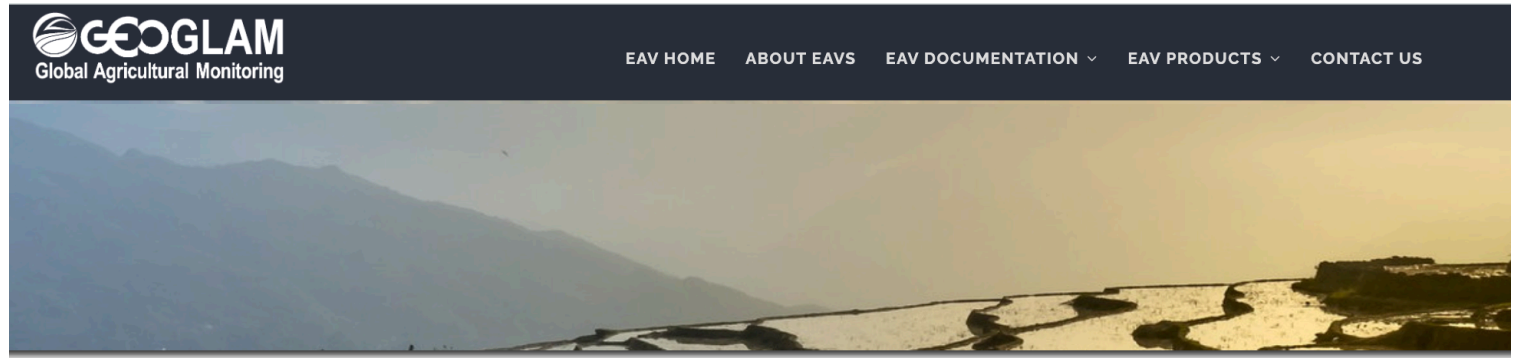
- Core Map Products
- Crop Productivity Metrics
- Climate & Weather
- Field/Crop Management

Non-Map Derived Products

EAV Website (Soft Launch)

AgVariables.org

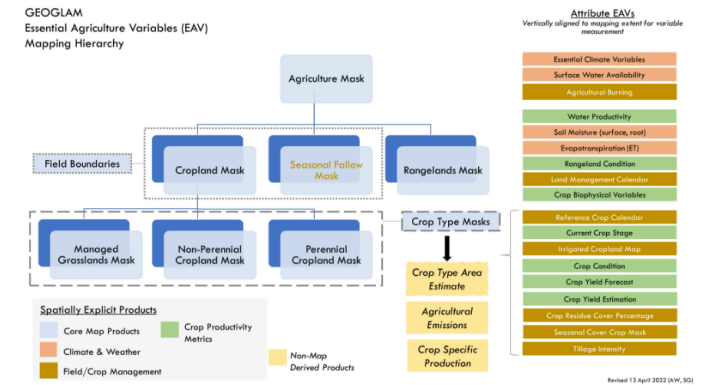
With thanks to Keelin Haynes
and Indu Kommareddy (UMD
- Harvest)



Essential Agriculture Variables & Agricultural Indicators for GEOGLAM

Essential Agricultural Variables for GEOGLAM are Earth observation-based “building blocks” that in combination with one another or with other non-EO information provide insight into the “GEOGLAM Agricultural Indicators” – which themselves provide actionable information on the state, change, and forecast of agricultural land use and productivity (Figure 1). GEOGLAM covers land devoted to agriculture, which is defined as the systematic and controlled use of land and livestock to produce food, fiber, and fuel. This includes croplands, rangelands, and short-term fallow lands.

The EAVs can be measured or inferred from satellite data, and are supported through field data for calibration and validation. They support the core work of GEOGLAM and its constituent communities, including supporting national and global policy frameworks (e.g. G20 Action Plan and UN Sustainable Development Goals).



[Full EAV Table](#)

[EO Data Requirements](#)

[EAV Product Priorities and Status Updates](#)

Crop Condition Assessment

Definition

Qualitative indicator of crop health status relative to short-term reference*
(*definition must be declared)

Agricultural Land Includes or is Indicated by

Each nationally relevant crop type, accounting for ~80% of total area under

GEOGLAM Agriculture Indicator Category

Productivity

EAV Stewards

Felix Rembold

Ian Jarvis

Inbal Becker-Reshef

Mario Zappacosta

Miao Zhang

Rogério Bonifacio

Shumilo, Leonid

Within Season Requirements:

Application or Policy Supported	Related Variables	Frequency of Update	Spatial Unit
Markets & trade, insurance, humanitarian, pest and disease impact monitoring	Non-Perennial Cropland Mask, Non-Perennial Crop Type Maps, Reference Crop Calendars, Current Crop Stage, Irrigation Events Timing, Seasonal Dynamics of Surface Water Availability, ETa, GDD, Above Ground Agricultural Biomass, LAI, fAPAR, LST, Precipitation, Wind Speed, Root zone soil moisture	Weekly to monthly, within each cropping cycle	Field and sub-national admin units

Productivity EAVs

Seasonal Dynamics of Surface Water Availability

Reference Evapotranspiration

Reference Crop Calendars

Leaf Area Index

Degree Growing Days

Fractional Cover

fAPAR

Current Crop Stage

Actual Evapotranspiration

Above Ground Agricultural Biomass

Surface Soil Moisture

Root Zone Soil Moisture

Precipitation

Land Surface Temperature

Air Temperature

Water Productivity

Rangeland Condition Assessment

Crop Yield Forecast

Crop Yield Estimation

Incoming Radiation

Relative Humidity

Wind Speed

Crop Condition Assessment

Land Use EAVs

Reference Evapotranspiration

Reference Crop Calendars

Non-Perennial Cover Crop Utilization Mask

Managed Grasslands Mask

Irrigated Cropland Map

Fractional Cover

Field Boundaries

Current Crop Stage

Crop Rotation Sequence

Crop Residue Cover Percentage

Seasonal Fallow Mask

Rangelands Mask

Perennial Cropland Mask

Non-Perennial Cropland Mask

Managed Grasslands Mask

Crop Type Area Estimate

Cropland Mask

Crop Type Masks

Agriculture Mask

Agronomic Management EAVs

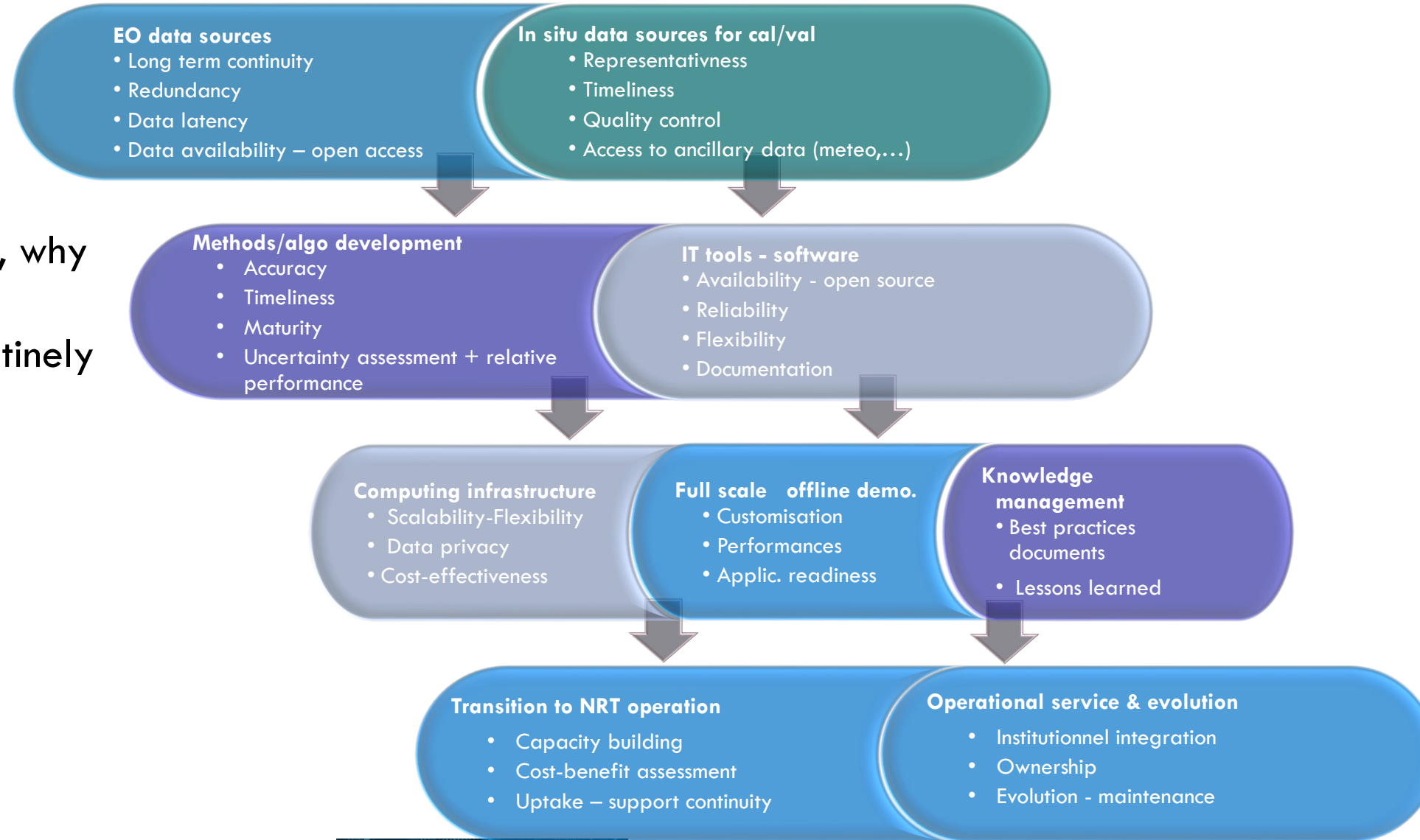
Tillage Intensity

Cover Crop

Agricultural Burning

Land Management Calendar

What's Next for EAVs?



- Obvious question:
 - If they are essential, why aren't they already being measured routinely and generated as products?
- Next step:
 - "Gap analysis"

Operationalizing the Data-to-Decision Cycle

- Observations:
 - CEOS (GEOGLAM subgroup of Land Surface Imaging Virtual Constellation)
 - In Situ Data Group
- Method Improvement & Documentation:
 - JECAM
 - R&D Agenda
- Product generation:
 - Call to Action →
 - Standard GEOGLAM EAV Products
- Operationalization:
 - "Best Practices" documentation
 - Capacity development priorities
- Developing a transparent process for identifying products that are generated as "EAVs"
 - must meet the definition for the specified EAV, including any stated minimum accuracy requirement, "product generation notes"
 - must be generated at a minimum of national-scale
 - must undertake error assessment
 - must be freely and publicly available
 - must have documentation in the form of a peer-reviewed paper
 - Does not have to be a journal

Some final notes

- This is a *process* – only as robust as there is buy-in and participation
- We welcome contributions !
- Call to community action:
 - Let's make some products!
 - And validate what there already is out there!

Thank you

AgVariables.org
GEOGLAM.org
@G20_GEOGLAM on Twitter

akwhitcraft@geoglam.org

How will GEOGLAM intersect EAVs with policy and markets?

- Bring the EAVs to the community at two levels:
 - At policy-level:
 - Through groups like GEO's EO4SDGs, IAEG-SDGs, G20 MACS
 - Socialize EAVs applicability to policies (tracing to top of data-decisions cycle)
 - Useful in AFOLU global stocktake and NAPs
 - At national/regional level
 - Development of national systems = the core of GEOGLAM's work
 - IAEG-SDGs itself relies upon national experts, ultimately leaves production of SDG indicator data to countries
 - With private sector:
 - They have made their own commitments to the 2030 Agenda and UNFCCC!
 - They are looking to "neutral" body to generate core agricultural data products

A note on Agronomic Management Variables

- There are as many ways to manage land as there are farmers.
 - The biophysical “footprint” of an agronomic decision usually requires more contextual information in order to be adequately mapped.
 - Also, GEOGLAM’s G20 policy mandate isn’t clear on definitions –
 - impossible to create a single definition for management variables that will be “fit for purpose.”
- Yet management practices are of critical policy and market relevance
 - UNFCCC stocktake of emissions from Agriculture, Forestry, and Other Land Uses (AFOLU)... LDN, SDG 2.4, etc.
 - Assetization of non-food commodities
- Acknowledging the growing remote-sensing based work on identifying a few key management practices that are highly incentivized, politicized, and financialized
 - We do not want to give a false impression that GEOGLAM only considers certain Agronomic Management variables to be “essential” - and thus, we have moved them to their own section.