EARTH SCIENCE
APPLIED SCIENCES

EARTH SCIENCE APPLICATIONS WEEK 2022

Day 3

August 11, 2022

EARTH SCIENCE APPLICATIONS WEEK 2022

WELCOME!

DAY 3 – AUGUST 11th: AGRICULTURE

<u>Event Attendance Guidelines</u>

1. Please stay muted with cameras off
2. Post questions for speakers in the chat & they will be answered there

OPENING REMARKS

Sandra E. Connelly
Deputy Associate Administrator
Science Mission Directorate

AGRICULTURE INTRODUCTION

Sarah Brennan
Deputy Program Manager
On behalf of Dr. Brad Doorn, Program Manager
Agriculture Program

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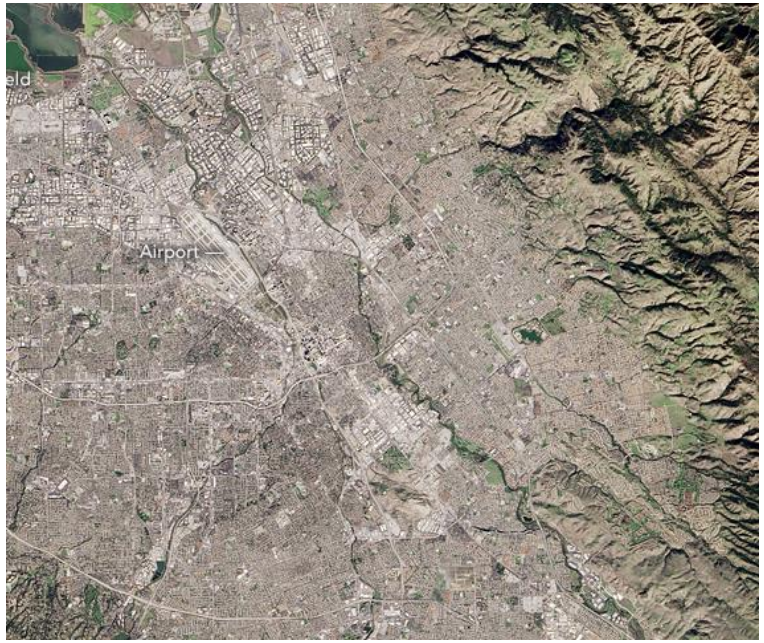
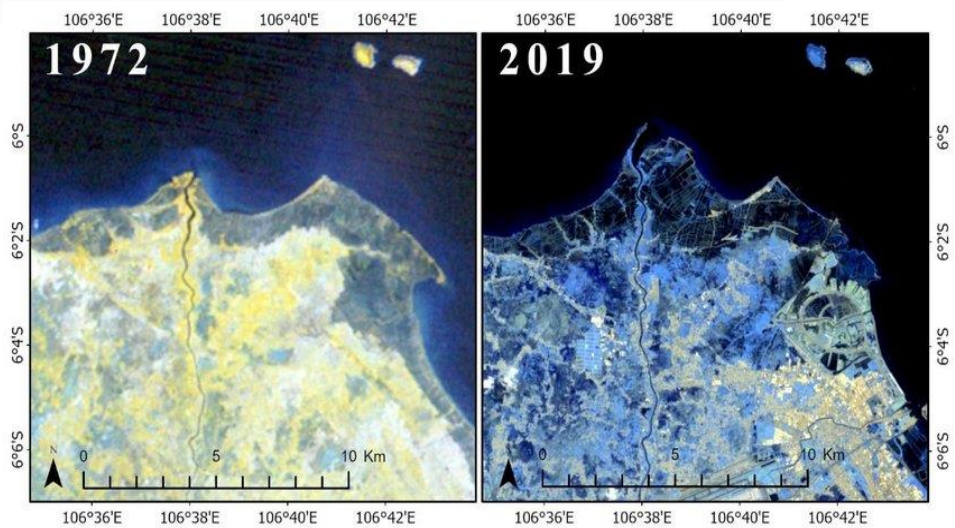
The Great Grain Robbery of 1972

- Unbeknownst to the US, Russia had a year of failed crops due to extreme drought.
- Russia bought 15 million tons of wheat, corn, soybeans and barley depleting US and international markets
- Low availability contributed to commodity price surges 1972-1974..
- Highlighted the need for global agricultural monitoring

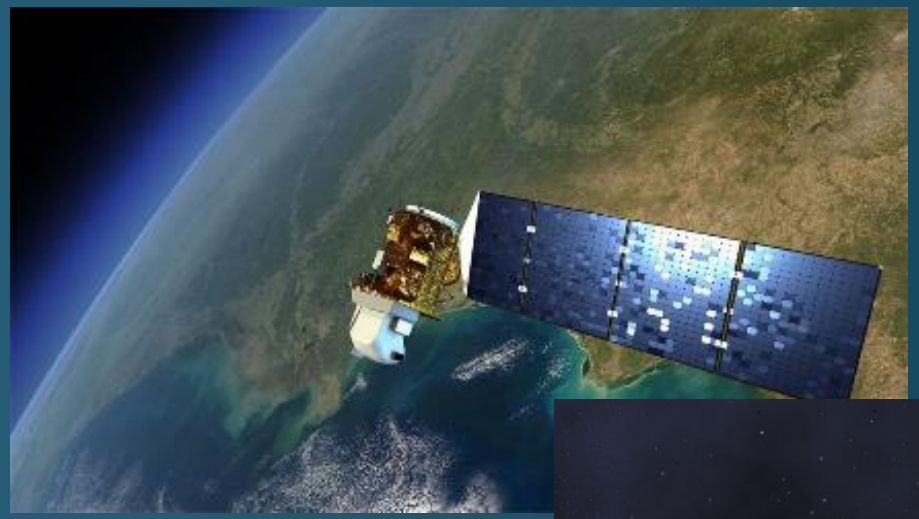
Celebrating 50 YEARS Landsat 1972-2022

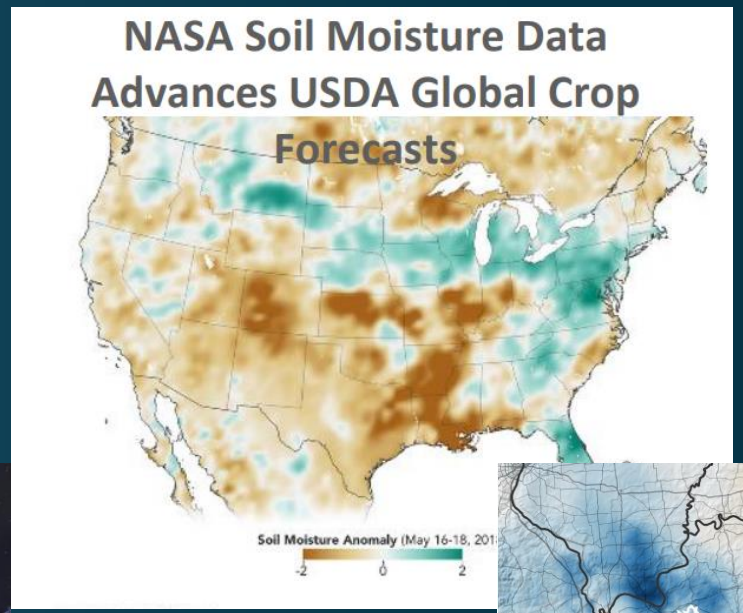


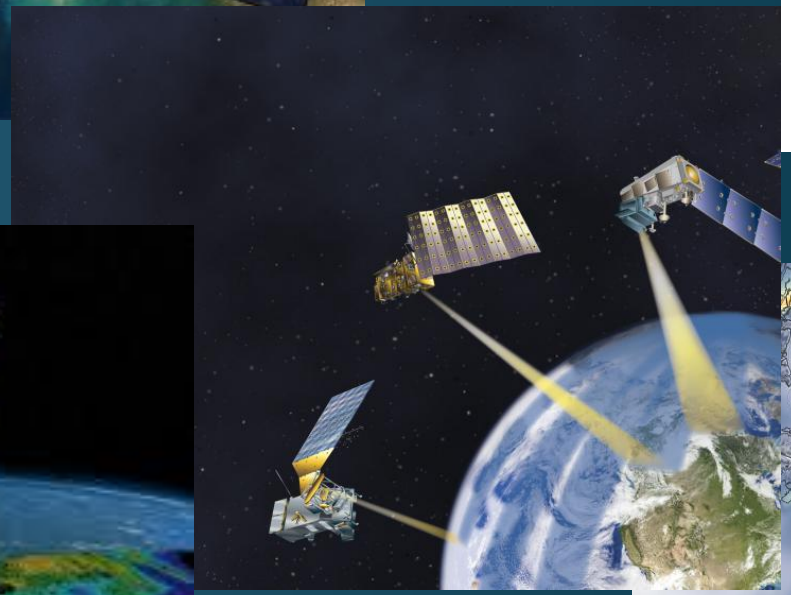


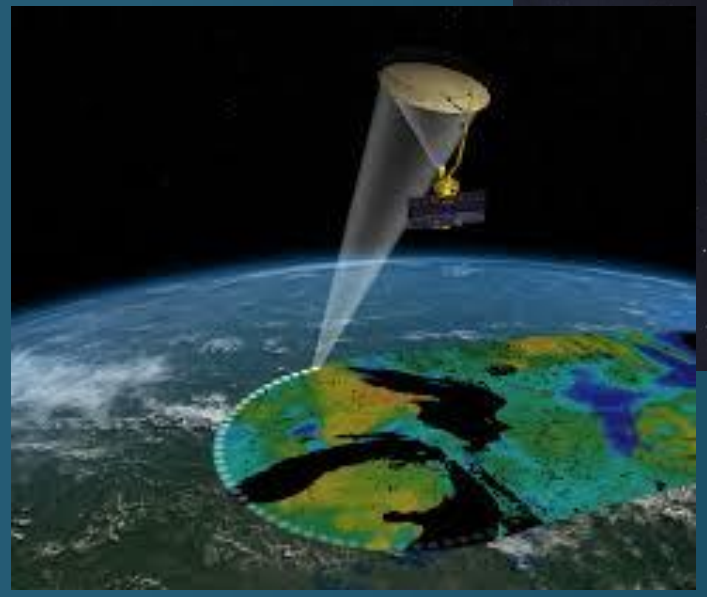
Landsat at 50

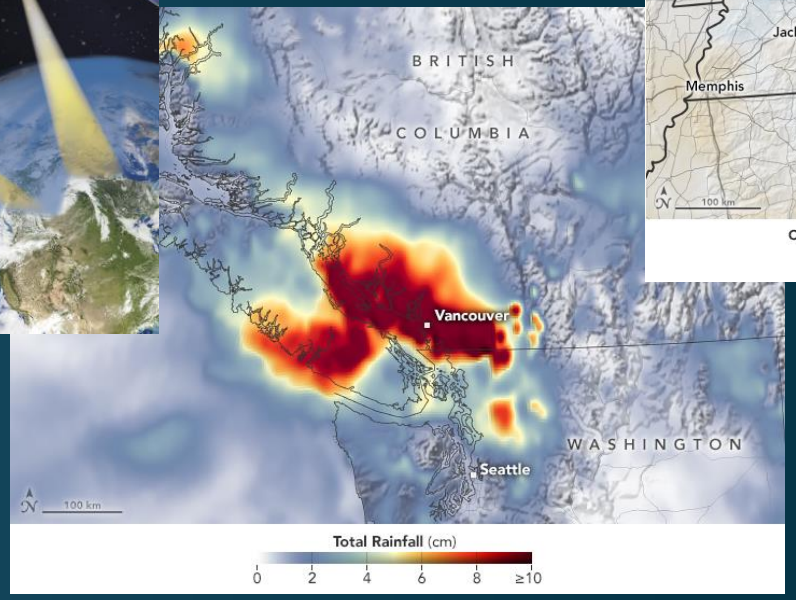
NASA Observations

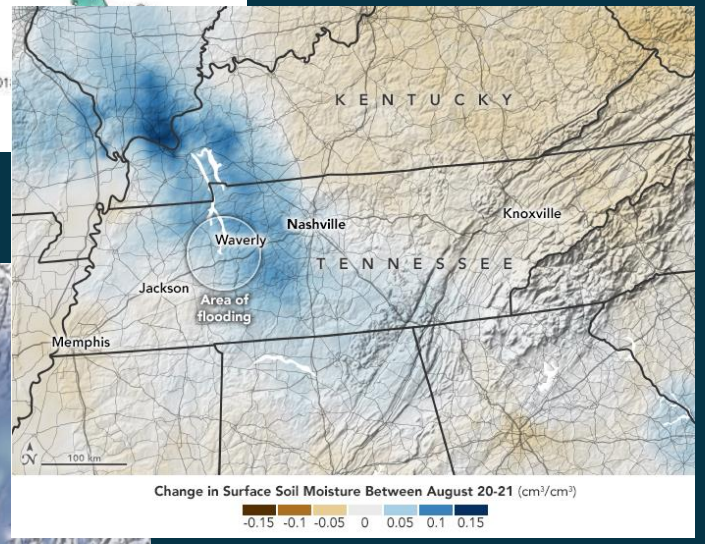












Information & Insights Important to Ag Producer Decisions

NASA's objective is to develop the next generation of satellites, instruments and data models to help inform producers on:

- Global market conditions
- Water management
- In-season crop conditions
- Severe weather
- Sustainability

Agriculture Application Area Program Elements

NASA Harvest - International agriculture and global food security program (Next presentation!)

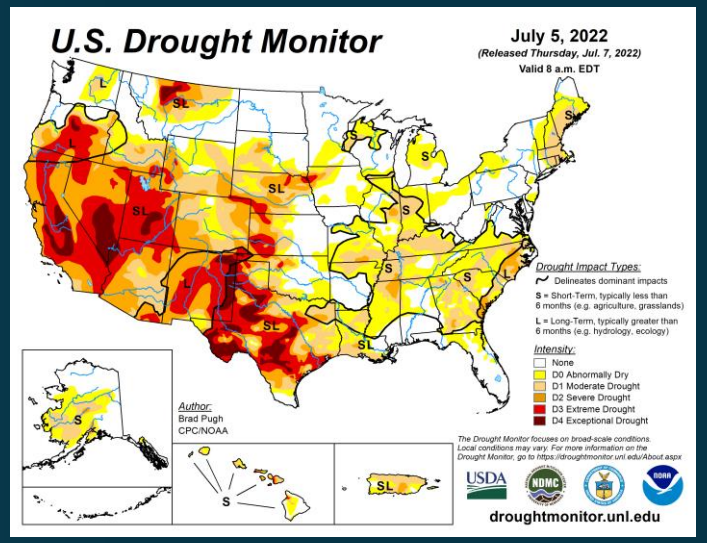
Domestic Agriculture Consortium (to be announced Fall 2022)

Contributions to NASA's Green House Gas Initiative

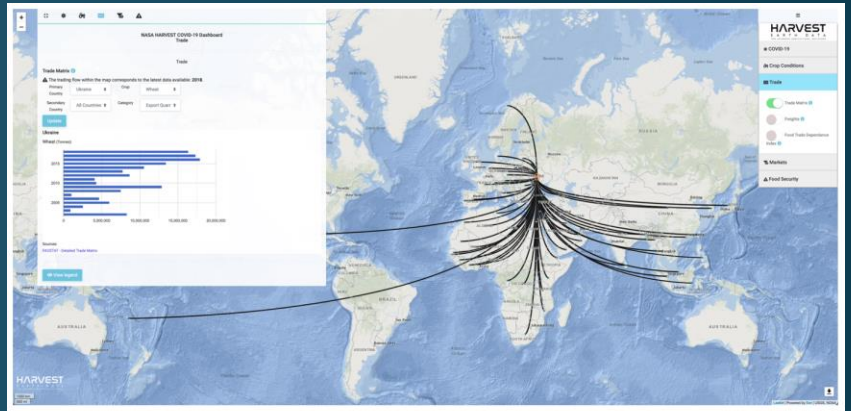
HQ driven Partnership Activities on Climate Smart Agriculture

Information Products and Tools

US Drought Monitor

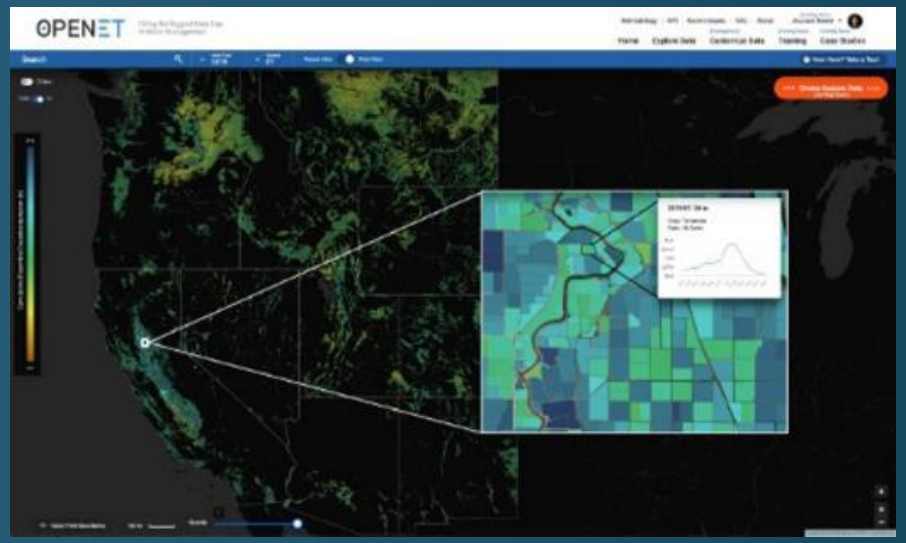


NASA Harvest Portal: Harvest2Market

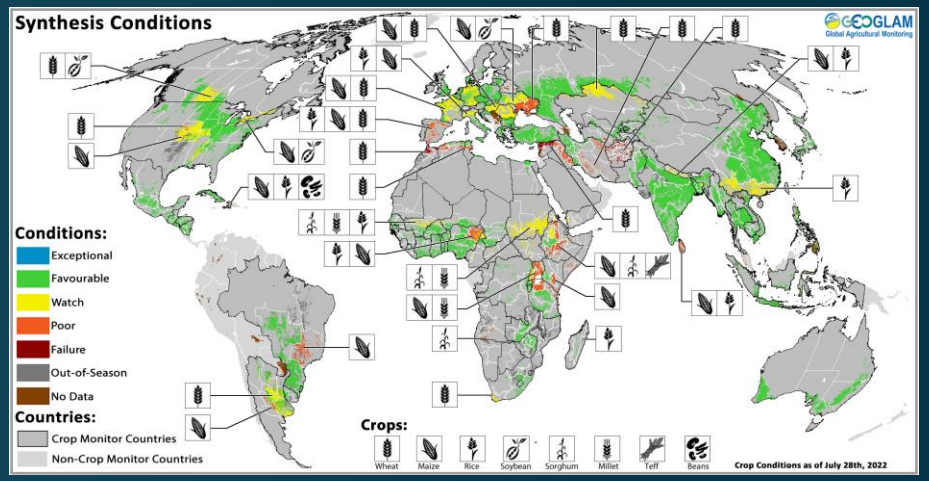


Ukraine is a massive exporter of global commodity crop supplies, with trade partners around the world reliant on imports from the region to accommodate their communities' food consumption needs. The major disruption in trade flow due to Russia's war has wide-reaching impacts both within Ukraine's borders and across the globe. (source: https://harvestportal.org/dashboard/)

OpenET



GEOGLAM Crop Monitor



Space For Ag Tour

ESD Director Karen St Germain and Agriculture Program Manager Brad Doorn

NASA ESD Leadership's Objective

Involve agricultural producers in the development of useful and practical guidance for Earth science applications. Engage producers and their allied industries through a strategic plan that incorporates direct outreach, communication and media

- Visit Kansas and Nebraska land grant universities and agricultural research institutes
- Visit with Nebraska and Kansas famers and Extension Educators
- Meet with crop association members

GET INVOLVED!

ENGAGE

WITH THE COMMUNITY

- NASA Harvest Twitter
- NASA Harvest newsletter

- Attend Events and Conferences

ACCESS

AND USE THE DATA AND TOOLS

- Agriculture Data Pathfinder
- NASA Harvest Website
- NASA Harvest Portal : Harvest to Market
- ARSET - Satellite Remote Sensing for Agricultural Applications

DRIVE

THE FUTURE

- Share the stories:
  - NASA at Your Table
- Provide feedback, needs, and suggestions!
- Support, encourage, and bring in new voices to the discussion!
- Advertise and become advocates for your own work and each other's work!

Up Next!

- 1:15pm: NASA Harvest Overview - *Mary Mitkish*
- 1:25pm: Project Highlight: OpenMapFlow: Rapid Map Creation with Machine Learning and Earth Observation - *Ivan Zvonkov*
- 1:30pm: Feasibility Study Snapshot: Maipo River Valley Agriculture Project - *Rishudh Thakur*
- 1:35pm: SERVIR Bhutan Services - *Filo Gomez*
- 1:45pm: Feasibility Study Snapshot: Bhutan Agriculture II - *Wangdrak Dorji, Tenzin Wangmo, Sonam Seldon-Tshering, Karma Dorjee*

Thank You!

For further questions, please contact:

- Bradley.doorn@nasa.gov, Program Manager Agriculture Application Area
- Sarah.Brennan@nasa.gov, Deputy Program Manager, Agriculture Application Area

NASA Harvest

NASA's Global Food Security and Agriculture Consortium

Mary Mitkish

NASA Harvest Asst Manager & Comms Lead

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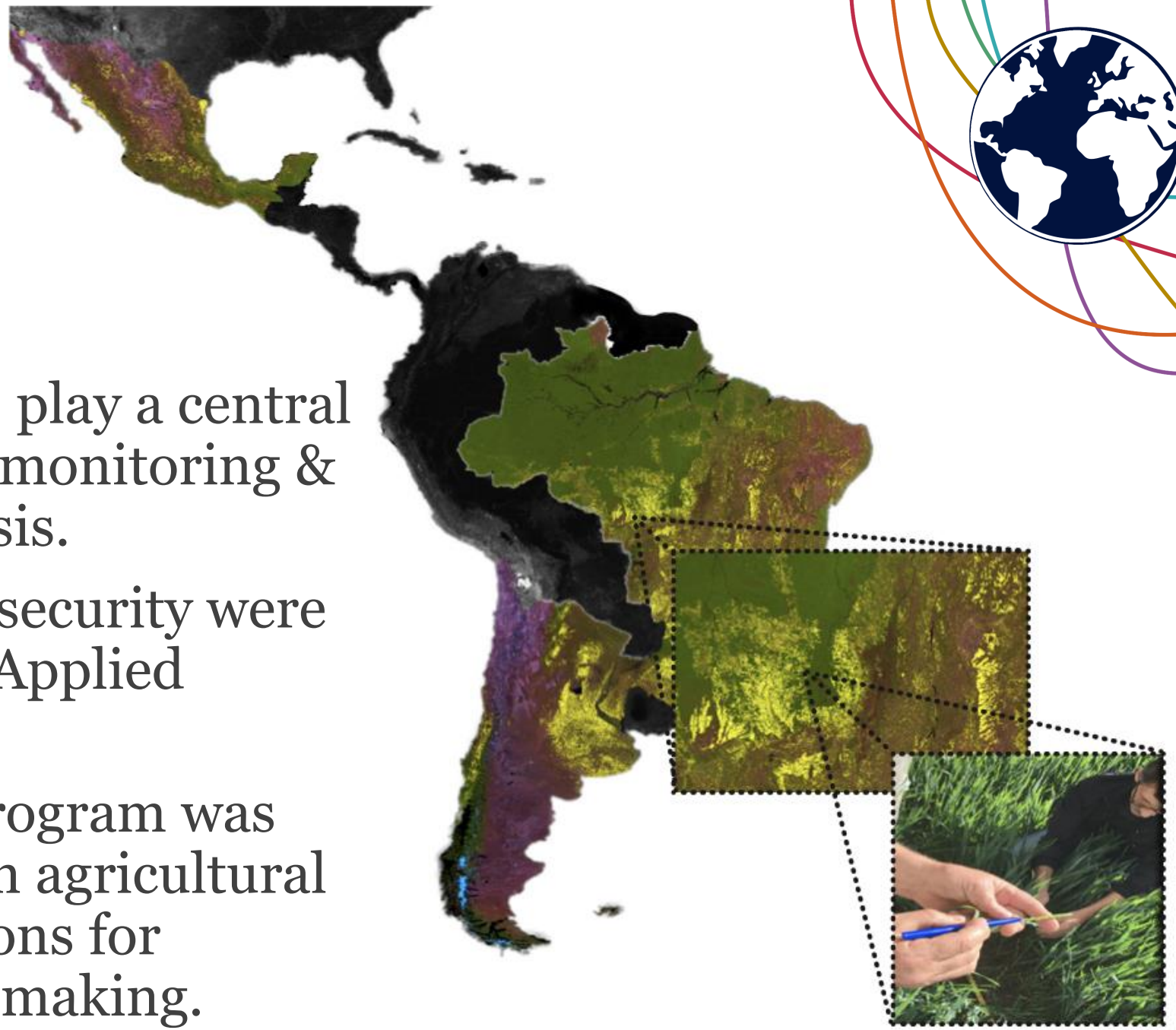
Background

NASA recognized:

1) Earth Observations play a central role in agricultural monitoring & food security analysis.
2) Agriculture & food security were critical gaps in the Applied Sciences Program.
3) A flexible & agile program was needed to transition agricultural research to operations for improved decision-making.

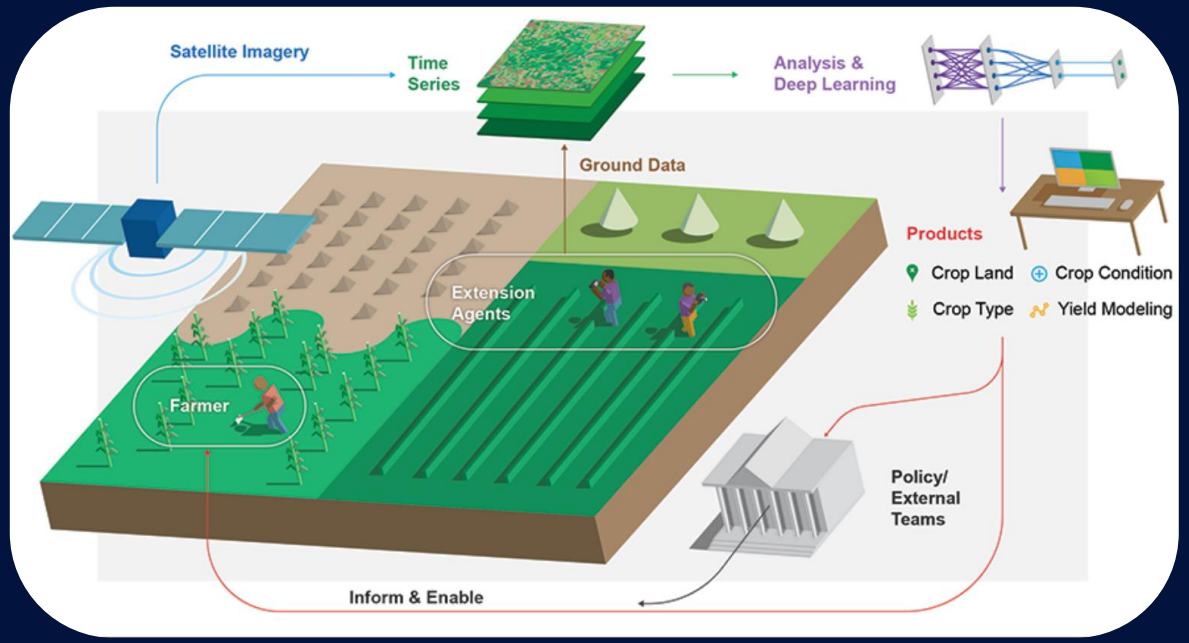


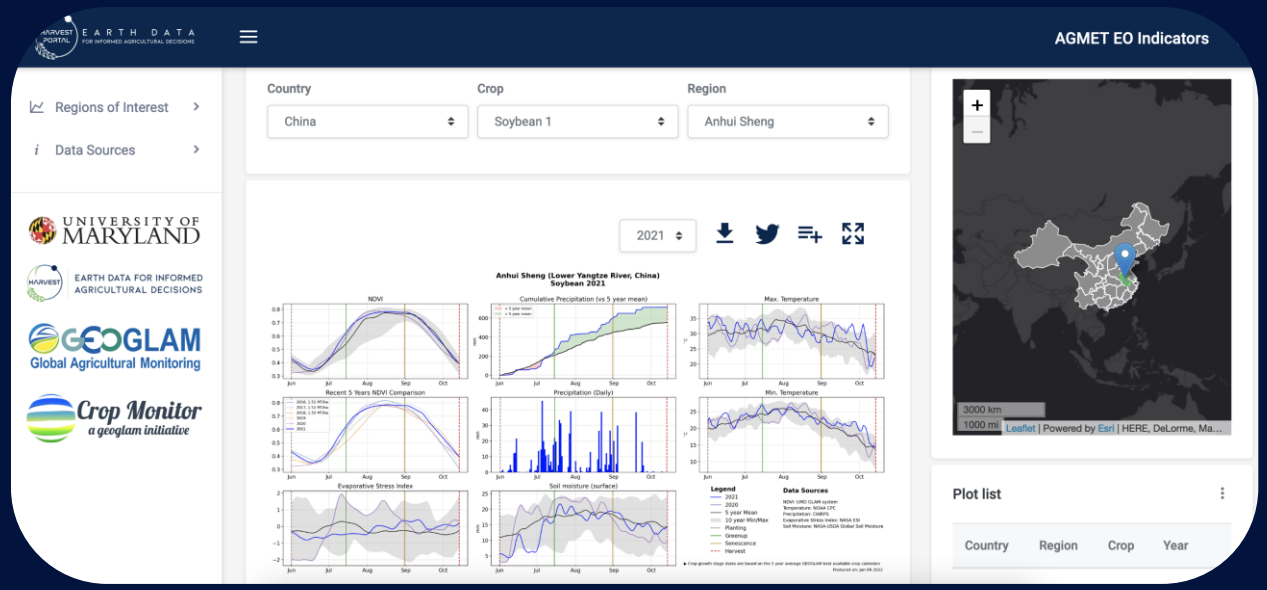
NASA Harvest Consortium

NASA Harvest is NASA's Global Food Security and Agriculture Program and NASA's contribution to GEOGLAM - operating as a consortium of 50+ partners around the world led by researchers at the University of Maryland (Inbal Becker-Reshef, PI).

Harvest Approach

We work directly with stakeholders to develop EO-based analytics and tools that inform ag decisions and improve understanding of our global agricultural systems.





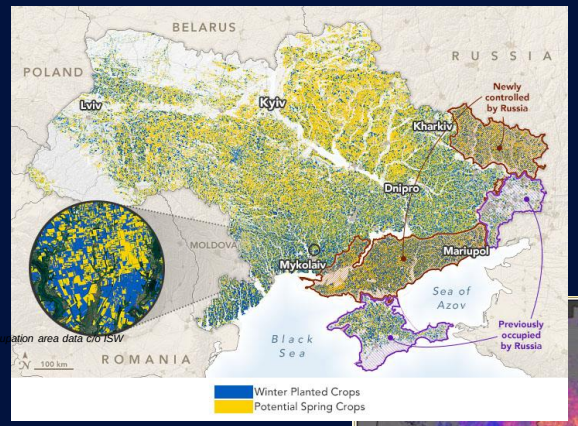
Programmatic Initiatives

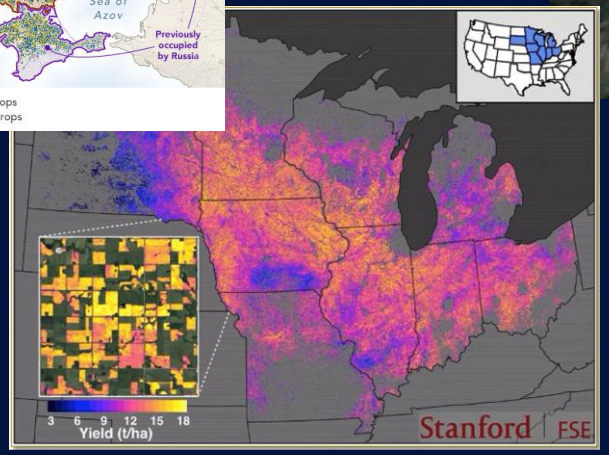
A wholistic initiative-focused approach drives Consortium activities, partnerships, and outcomes.

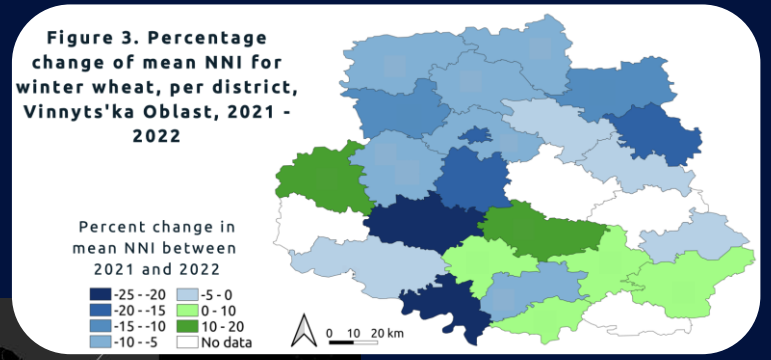
- Public-Private Partnerships
- Data Systems & Integration
- Markets, Trade and Supply Chains
- Artificial Intelligence & Machine Learning
- Early Warning for Early Action
- Sustainable and Regenerative Agriculture
- GEOGLAM
- Rapid Action for Agricultural Policy Support

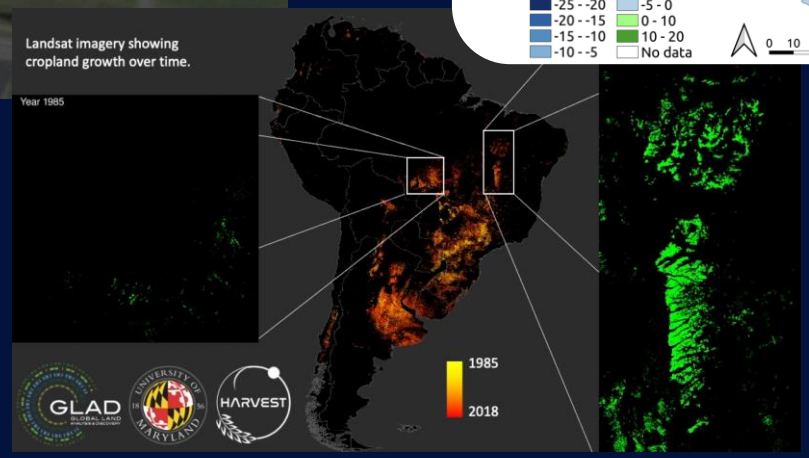
End-User Focused

Users will not adopt new technologies if they do not have ownership of and involvement in the development process, no matter how accurate or robust the product.



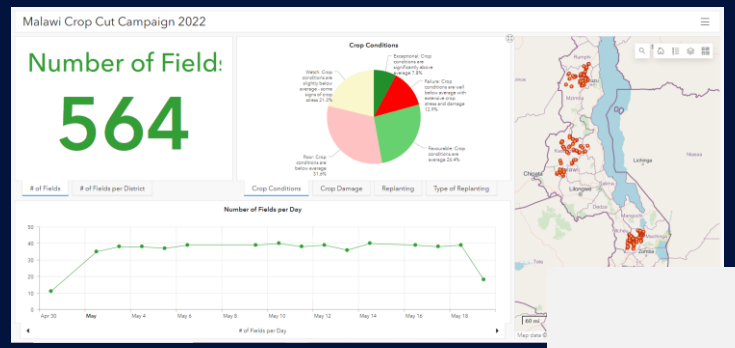


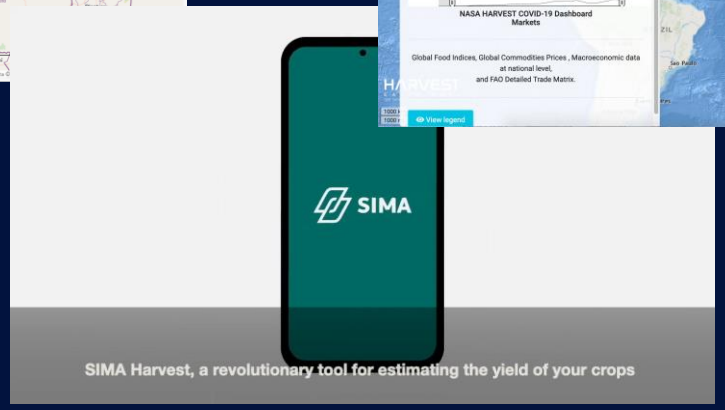


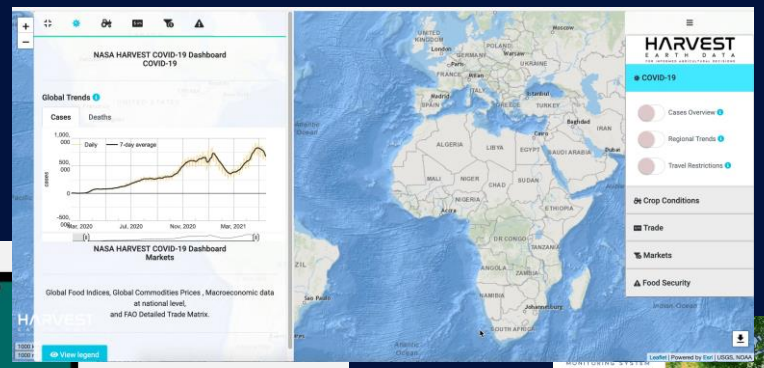


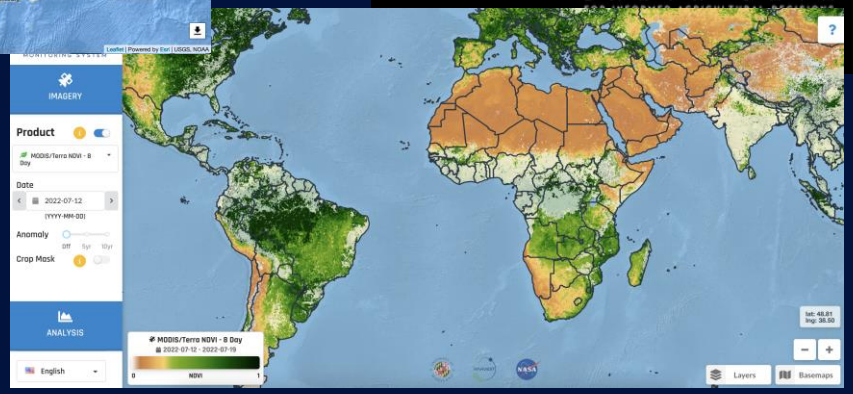
EO-Based Tools

Putting satellite data into the hands of end-users to bolster: agrifood system resilience, food security, conservation farming, agricultural productivity, and market stability.









Goals

- Answer demand across agricultural sector for EO-based actionable info & decision support
- Improve science quality & community engagement
- Build bridges between previously siloed communities
- Global recognition of NASA leadership and expertise in the field
- Preservation, connection, & continuity of project outputs (knowledge & data)
- Rapid action capability for emergent agriculture, food situations, and policy questions
- Greater equity, inclusion, & increased diversity in RS of agriculture
- Forge strategic partnership across sectors and geographies
- Demonstrate value and success of EO data for food security applications & adapt and scale tools

Thank You!

Inbal Becker-Reshef, Director, ireshef@umd.edu
Chris Justice, Chief Scientist, cjustice@umd.edu
Alyssa Whitcraft, Deputy Director, alyssakw@umd.edu
Mary Mitkish, Assistant Manager, mmitkish@umd.edu

@HarvestProgram
www.NASAHarvest.org

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OpenMapFlow

Rapid Map Creation with Machine Learning and Earth Observation Data

Ivan Zvonkov

Machine Learning Engineer, NASA Harvest

Team Members

Ivan Zvonkov
Harvest ML Engineer

Dr. Hannah Kerner
Harvest AI Lead

Dr. Catherine Nakalembe
Harvest Africa Program Director

Gabriel (Gabi) Tseng
Harvest ML Engineer

1. Machine learning + remote sensing

2. OpenMapFlow overview

3. How we are using it

4. Long term vision

1. Machine learning + remote sensing

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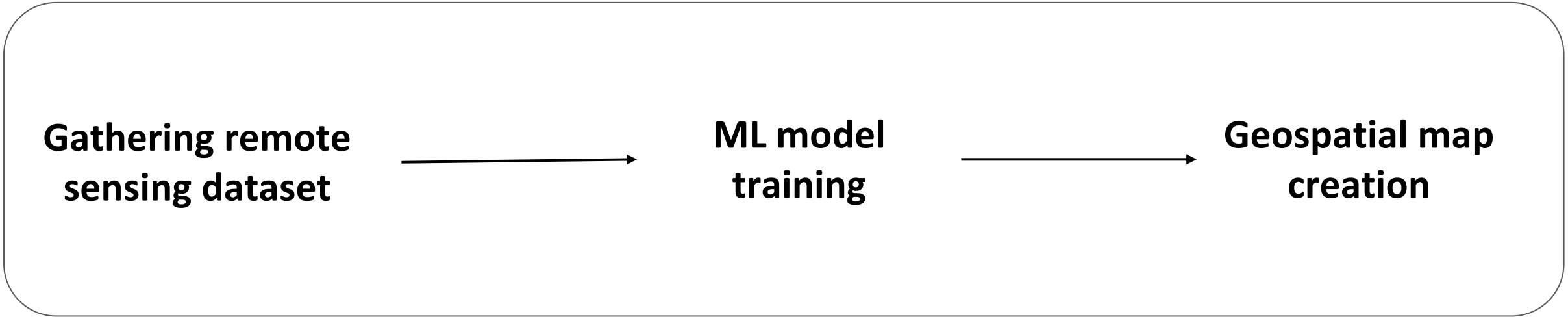
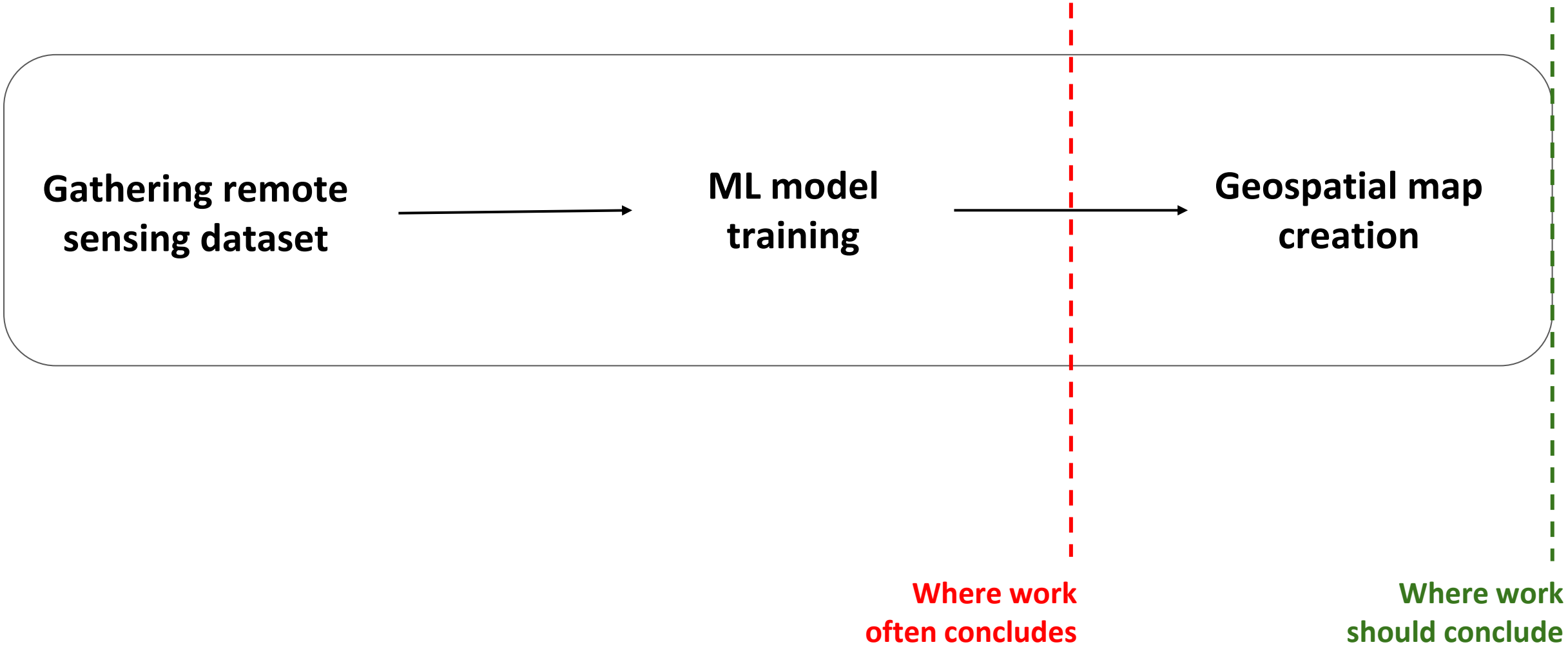
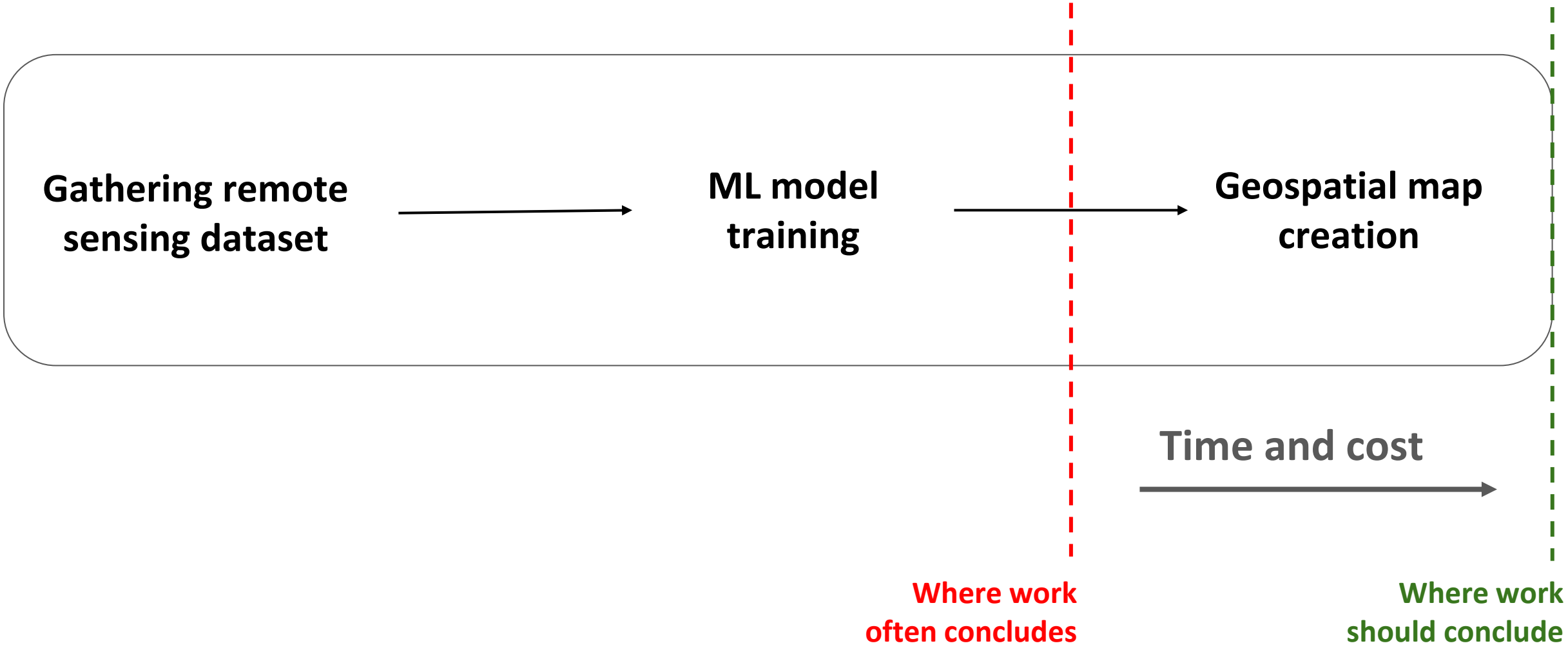
Machine learning workflows in remote sensing



Machine learning workflows in remote sensing



Machine learning workflows in remote sensing



1. Machine learning + remote sensing

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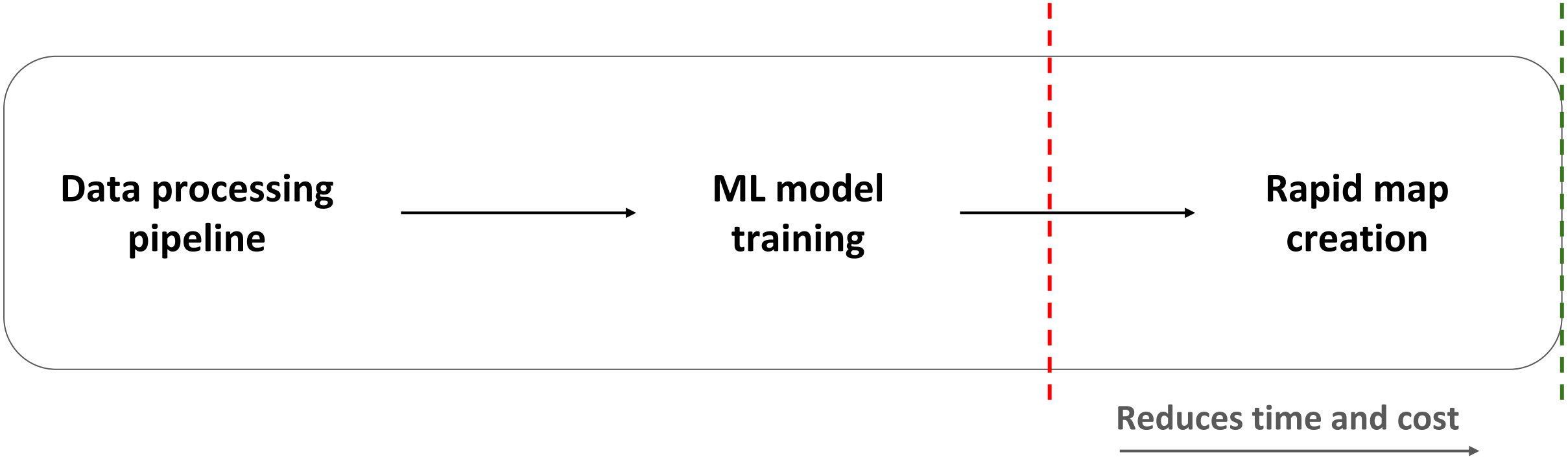
OpenMapFlow

Rapid map creation with machine learning and earth observation data

Data processing pipeline → **ML model training** → **Rapid map creation**

OpenMapFlow

Rapid map creation with machine learning and earth observation data



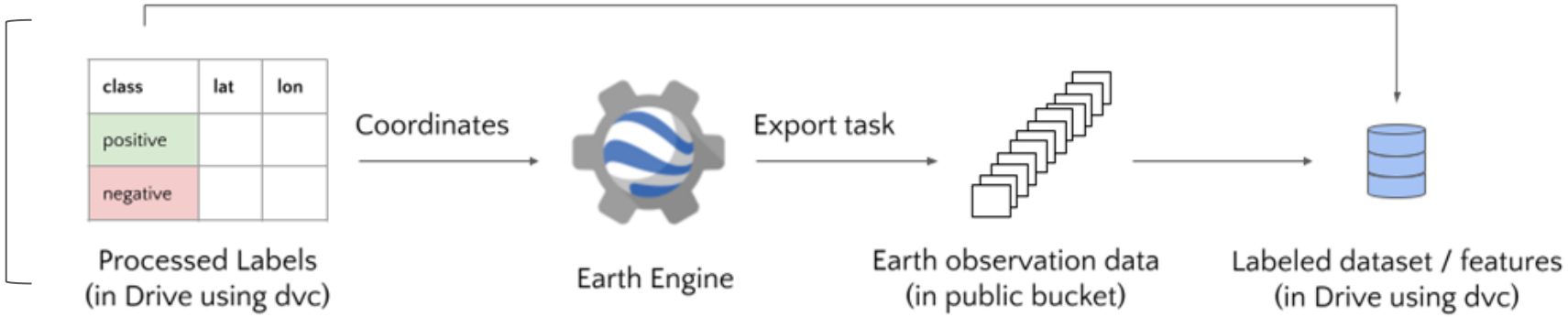
Data processing pipeline

↓

ML model training

↓

Rapid map creation



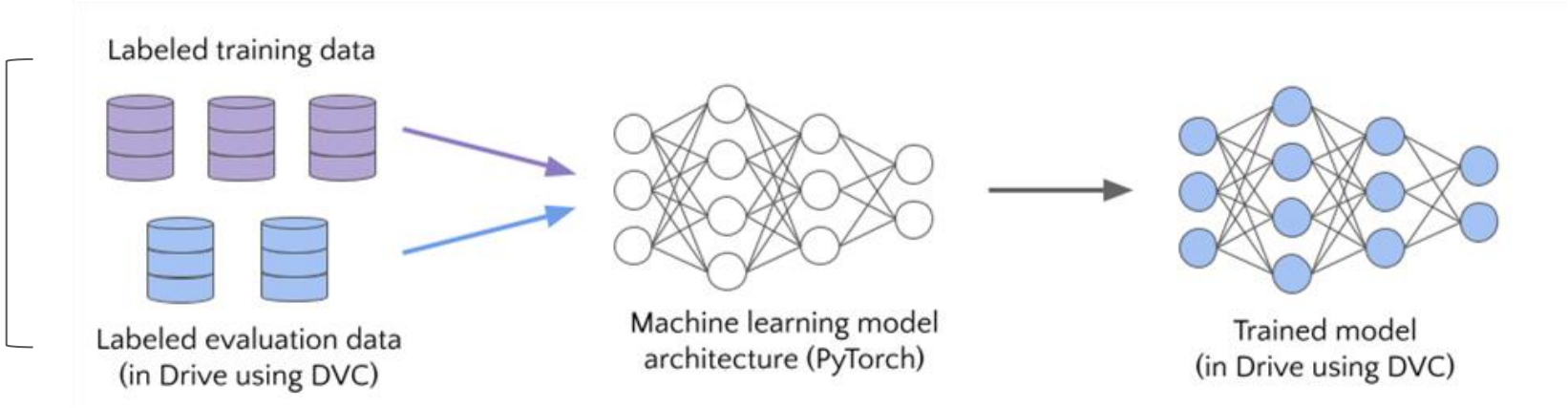
Data processing pipeline

↓

ML model training

↓

Rapid map creation



Data processing pipeline

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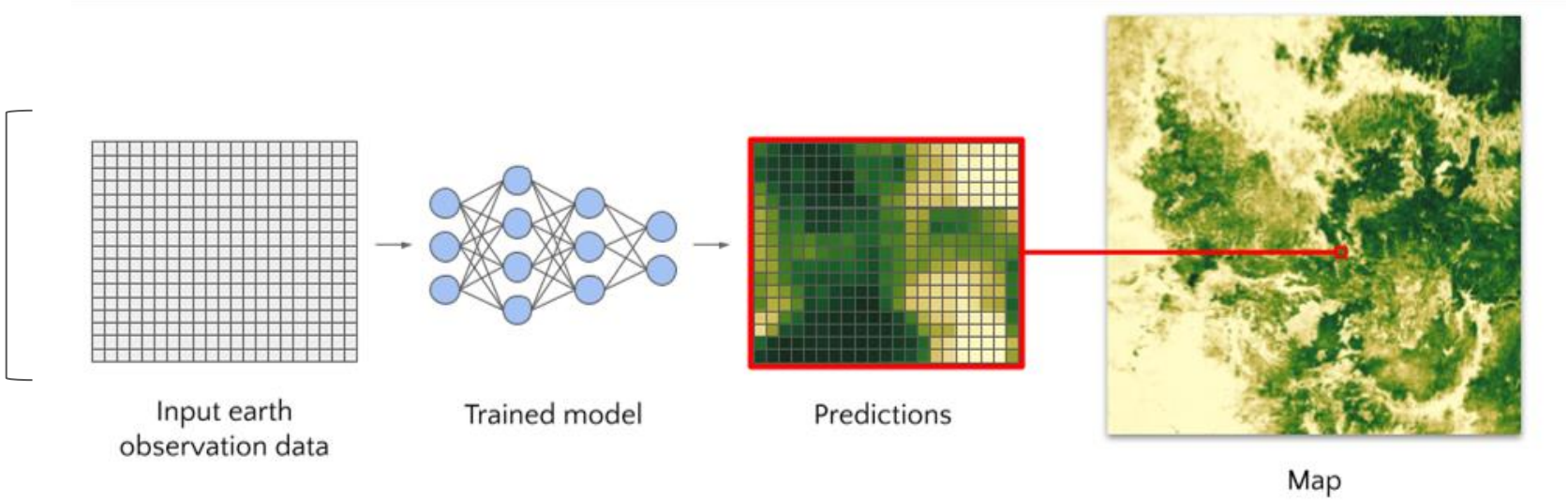
ML model training

↓

Rapid map creation



Data processing pipeline

↓

ML model training

↓

Rapid map creation

openmapflow 0.0.1rc1

```
pip install openmapflow
```

1. Machine learning + remote sensing

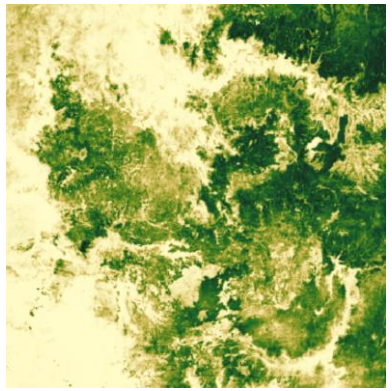
2. OpenMapFlow overview

3. How we are using it

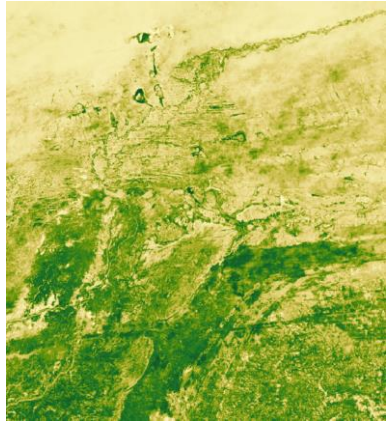
4. Long term vision

Current uses

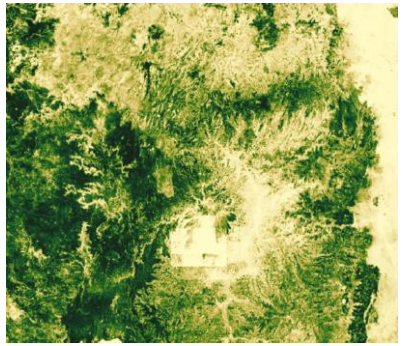
Ethiopia
Bure
Jimma
2020

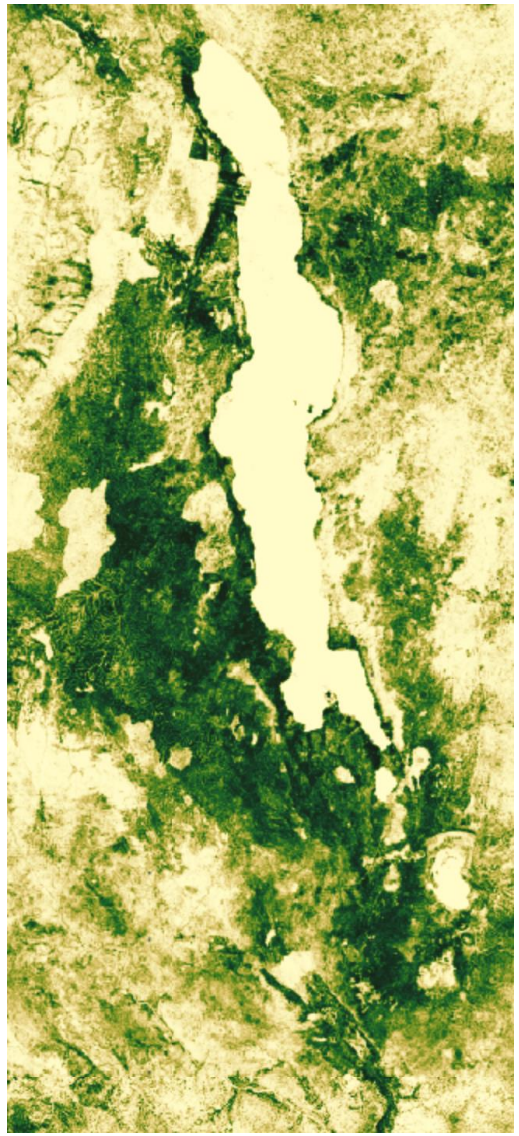


North
Mali
2019



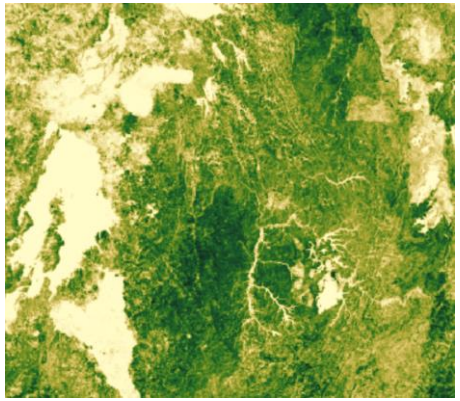
Ethiopia
Tigray
2021



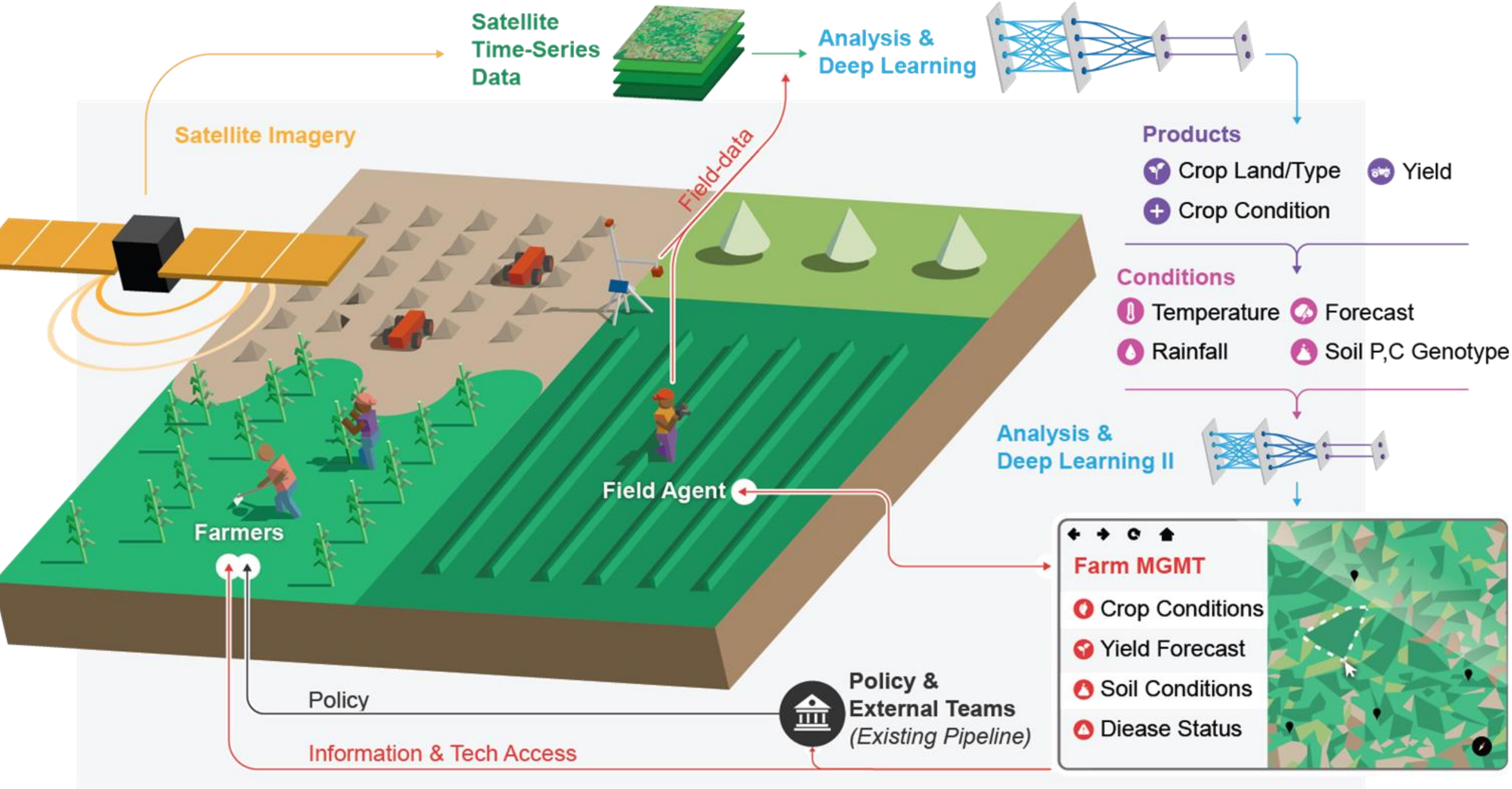


Malawi 2021

Uganda
2019



Rwanda
2019


Satellite Time-Series Data
Analysis & Deep Learning
Satellite Imagery
Field-data
Products
Crop Land/Type
Yield
Crop Condition
Conditions
Temperature
Forecast
Rainfall
Soil P,C Genotype
Analysis & Deep Learning II
Field Agent
Farmers
Farm MGMT
Crop Conditions
Yield Forecast
Soil Conditions
Diease Status
Policy
Policy & External Teams
(Existing Pipeline)
Information & Tech Access

1. Machine learning + remote sensing

2. OpenMapFlow overview

3. How we are using it

4. Long term vision

Long term vision

1. Multi-class classification
2. Custom earth observation data formats
3. Training with spatial dimension
4. Widespread adoption by the community

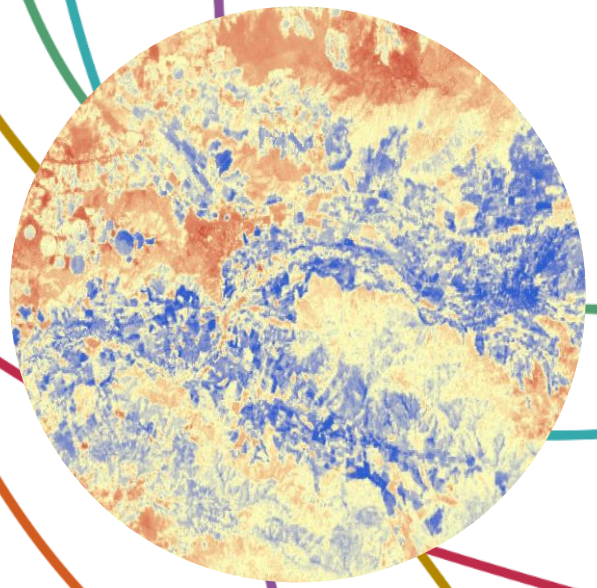
OpenMapFlow Contribution

Rapid map creation with machine learning and earth observation data

OpenMapFlow Library: github.com/nasaharvest/openmapflow
Crop mapping with OpenMapFlow: github.com/nasaharvest/crop-mask

Maipo River Valley Agriculture

Determining Crop Coefficients Using Remote Sensing for the Maipo River Valley Basin in Chile



TEAM: Rishudh Thakur, Benjamin Goffin, Duncan Srsic, Sarah Carlos

ADVISORS: Dr. Venkatraman Lakshmi (University of Virginia)
Dr. Kenton Ross (NASA Langley Research Center)

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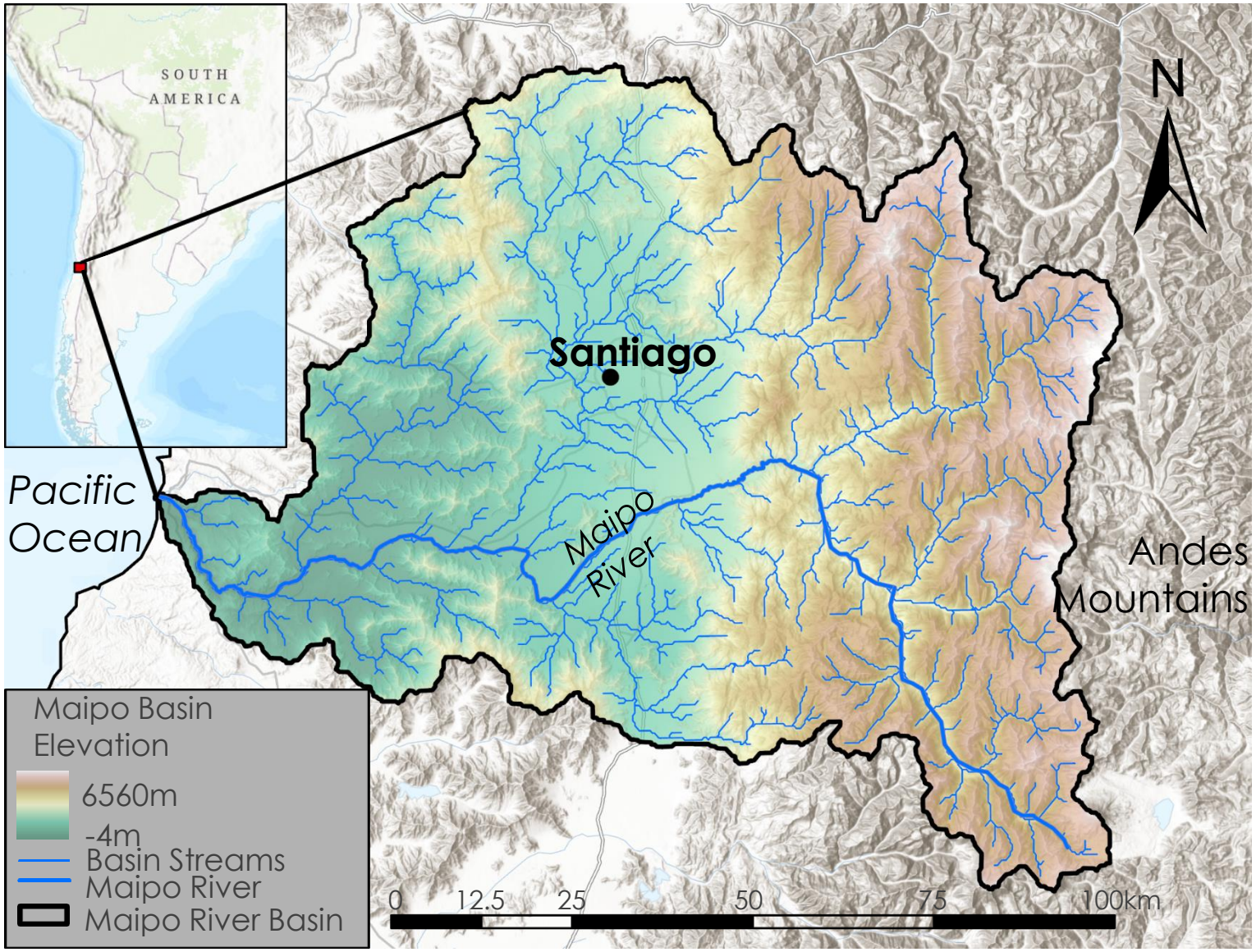
COMMUNITY CONCERNS & PROJECT OBJECTIVES



Sources: CIREN, FAO, NOAA, USGS, Esri, HERE, Garmin, Foursquare, METI/NASA, CGIAR

The region is experiencing extreme water scarcity, putting irrigated agriculture at risk!

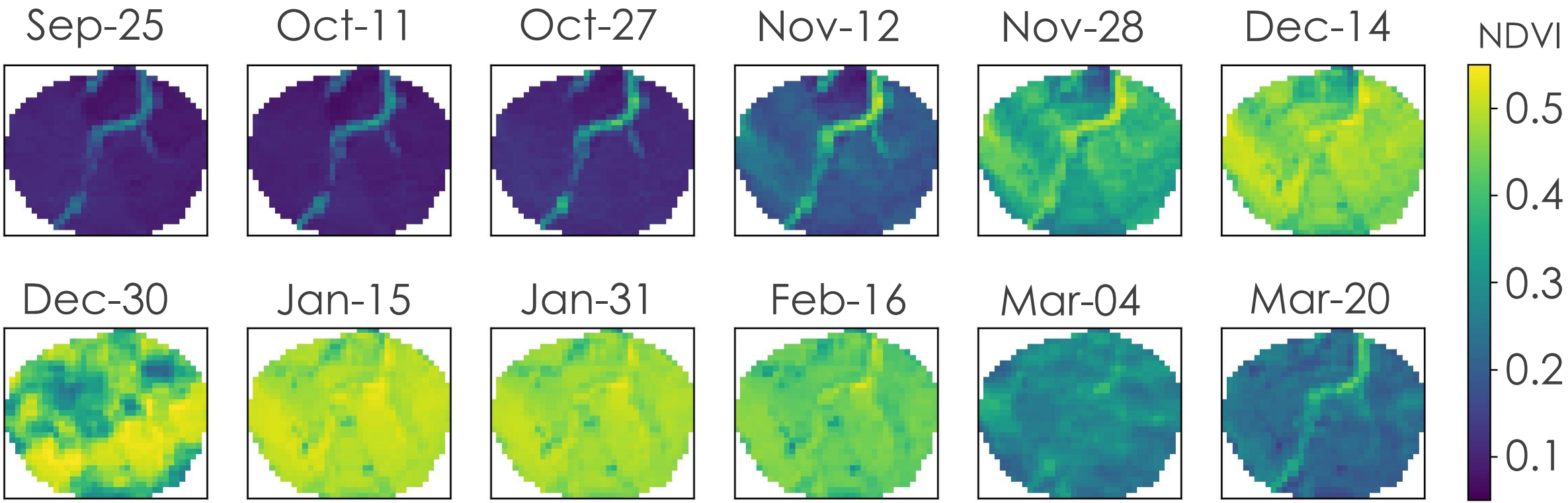
We **evaluated** agricultural water demand based on

- Remote sensing

We **obtained** crop coefficients (Kc) specific to Maipo's

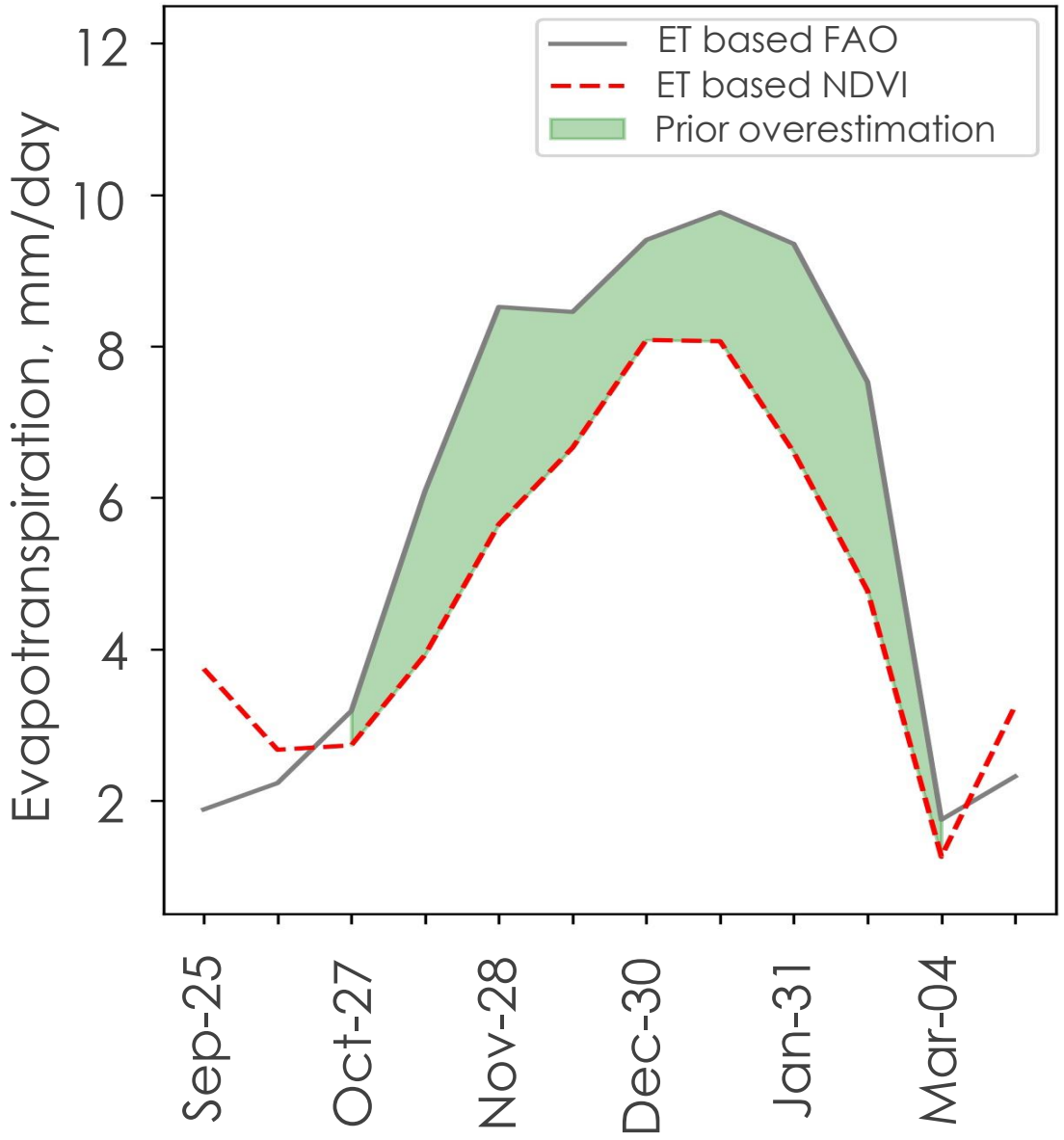
- Geography
- Climate

DATA & RESULTS



- Studied the relationship between NDVI and Kc at **8 sites**
- Produced **1 regional model**, which was validated at **4 locations**

CONCLUSIONS & SIGNIFICANCE



Maipo River Valley Agriculture project

- Captured **overall trends** and **site-specific signals** in vegetation health
- Showed the potential to:
  - Assess actual irrigation needs
  - Inform water management

Through partnership with and in support of:

- Centro de Información de Recursos Naturales (CIREN)
- Embassy of Chile, Agricultural Office

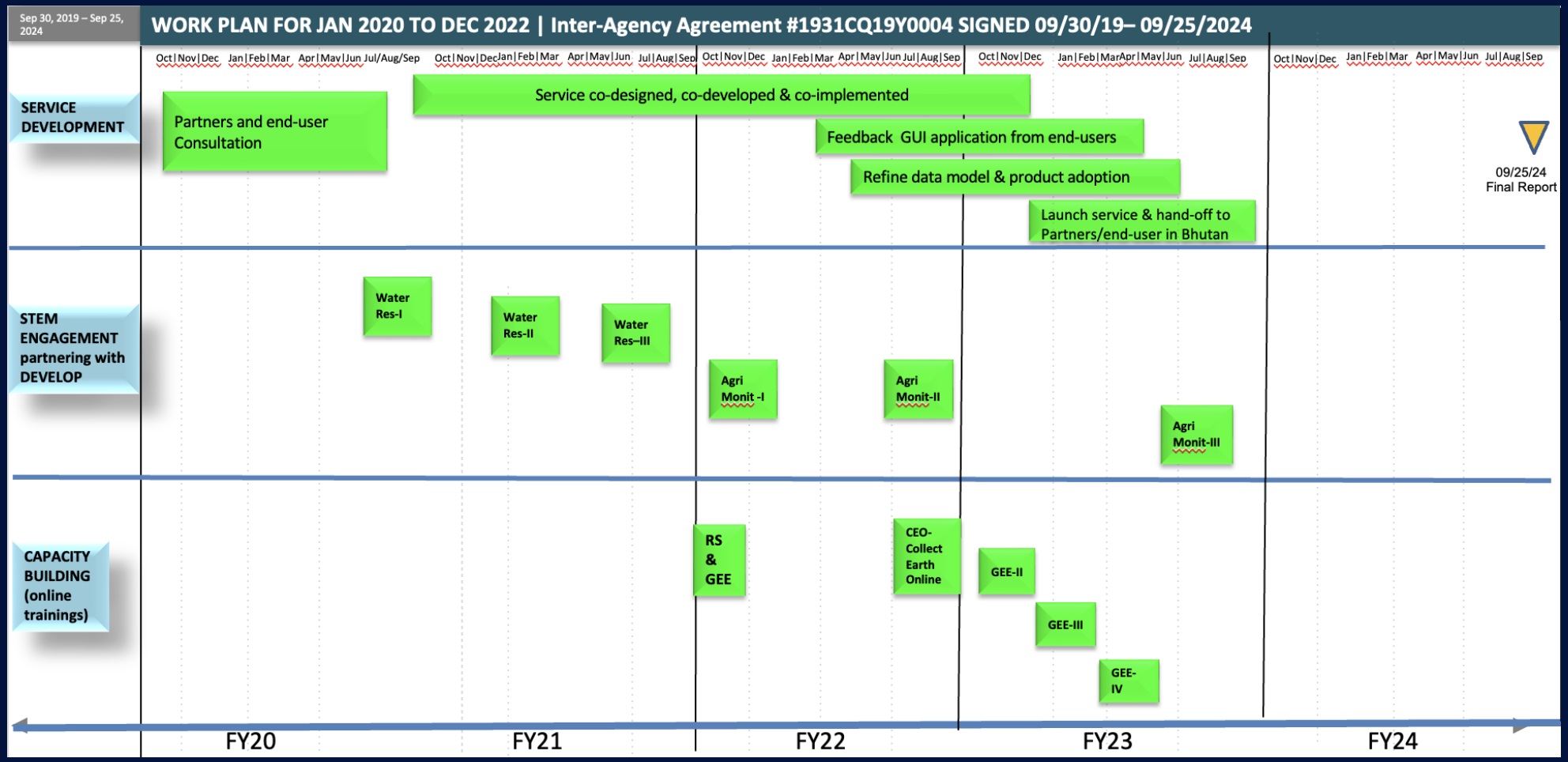
SERVIR STEM Engagement in Bhutan

Filo Gomez

SERVIR, Bhutan Fellow

EARTH SCIENCE
APPLICATIONS WEEK 2022

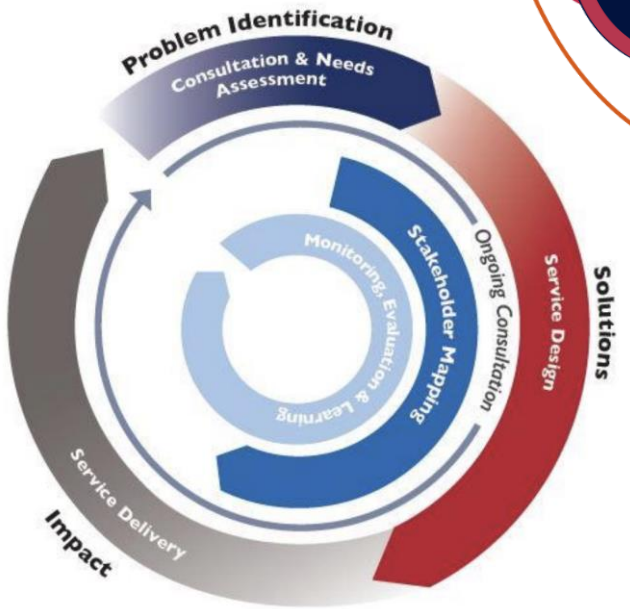
SERVIR's Side on STEM Engagement in Bhutan

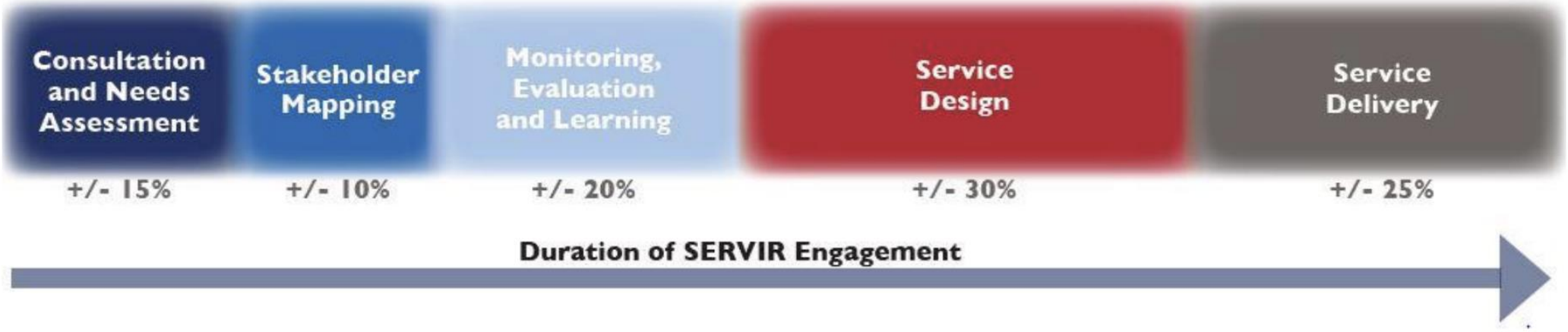


On Service Development

SERVIR Service Planning Toolkit

SERVIR SERVICE AREAS	
Agriculture and food security	Land cover and ecosystems
Water + water-related disasters	Weather and climate

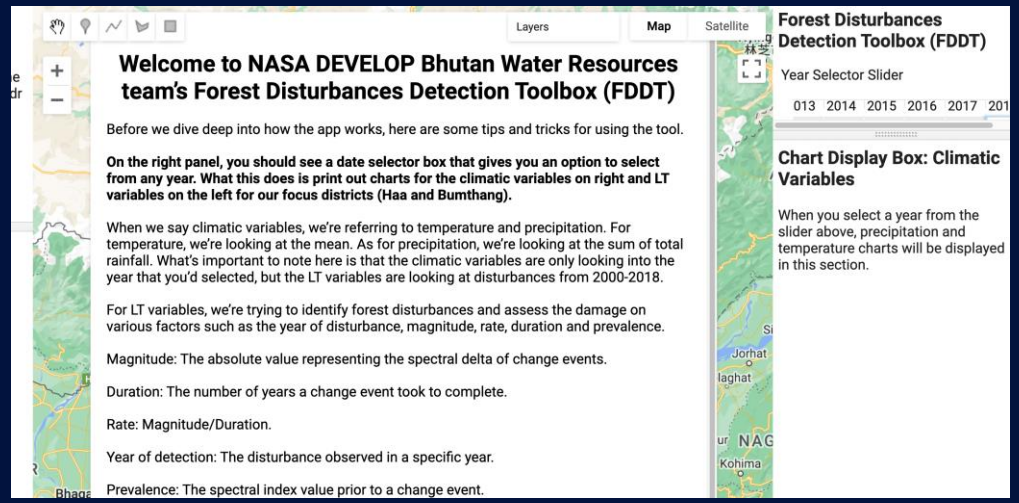




On STEM Engagement

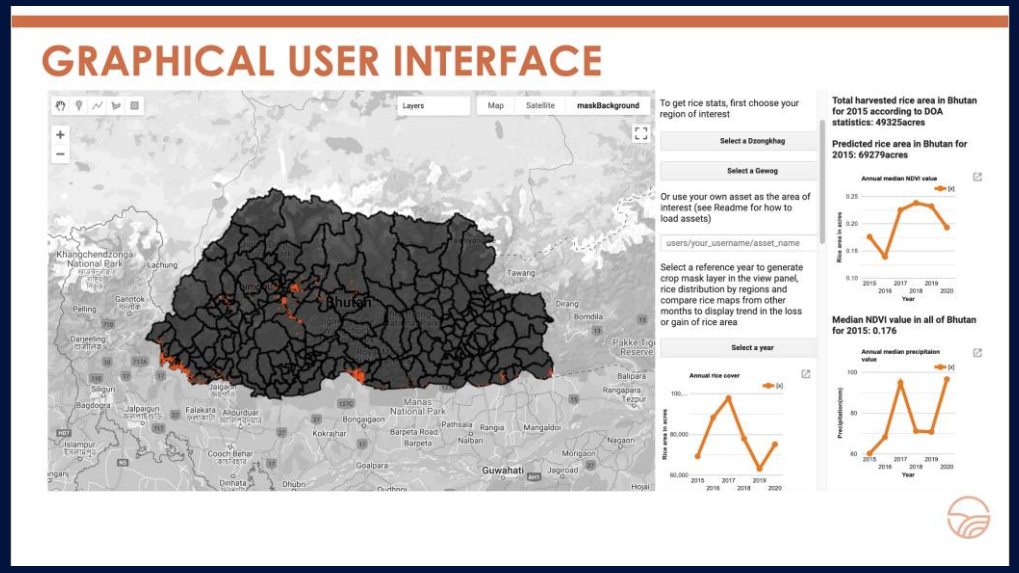
- **SERVIR** and **DEVELOP** Programs have collaborated on 5 Bhutan DEVELOP project

- *Water Resources I, II & III* (all completed)



- *Agriculture I & II*

(2 completed and 1 more to go)



SERVIR on Capacity Building in Bhutan

SERVIR conducted its first virtual training in Bhutan (29 & 30, Nov. 2021)

- Fundamentals of Remote Sensing
- Google Earth Engine (GEE)

On June 27, 2022

- On Collect Earth Online

Currently, SERVIR and Bhutan partners are coordinating for future training on GEE

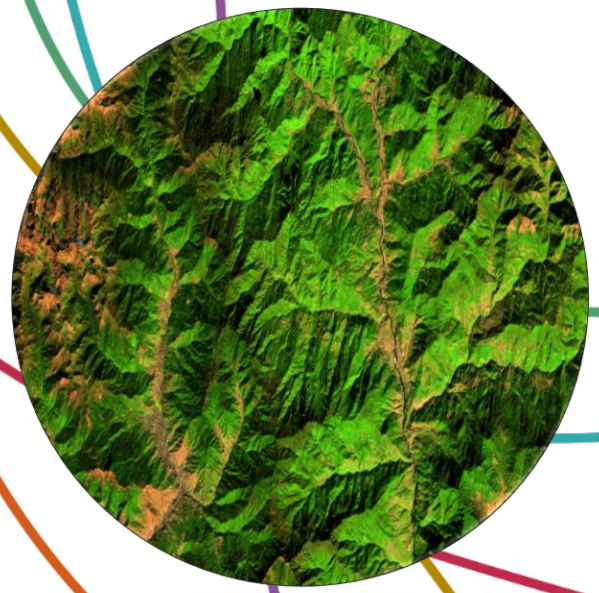
Anticipated project outcomes and current status

Anticipated:

- **GLOBE**: **at least 30** primary and secondary training complete
- **DEVELOP** at least **12** Bhutanese Scholars participated in DEVELOP project
- **SERVIR** improve capacity in at least **1** institution

Current Status:

- **GLOBE**: have trained at least **50** primary and secondary training complete
- **DEVELOP** & **SERVIR** at least **15** Bhutanese Scholars participated in DEVELOP project
- **SERVIR** improved capacity **1** institution and **other on the way**
- Service Development
- Capacity Building in Bhutan



Bhutan Agriculture II

Creating a Graphical User Interface, Crop Mask, and Data Collection Protocol for Analysis of Rice Crop in Bhutan using Remotely Sensed Data

TEAM: Wangdrak Dorji, Tenzin Wangmo, Karma Dorjee, Sonam S. Tshering

ADVISORS: Tim Mayer, Filoteo Gomez-Martinez, Biplov Bhandari, Meryl Kruskopf, Stephanie Jimenez, Kaitlin Walker, Micky Maganini, Sean McCartney, Dr. Kenton Ross, Dr. Robert Griffin and Dr. Jeffrey Luvall

EARTH SCIENCE
APPLICATIONS WEEK 2022

OBJECTIVES

Create a graphical user interface (GUI) for crop analysis

Expand the overall research area in Bhutan to produce a more robust crop mask for rice

Tune the random forest parameters to yield optimal performance in creating the crop masks

Streamline previous term's data collection protocol for feasible use and generalizability to any crop

Aid Decision Making Process

METHODOLOGY

INPUT DATA

Sampling rice and non-rice points(Collect Earth Online)

Split all points intro training, validation, and testing set (Google Earth Engine)

PROCESSING AND TUNING

Train and tune Random Forest classifier

Define Variables

- Optical Indices: NDVI, MNDWI, SAVI, NDWI, NDBI and NDMI (Landsat 8 OLI)
- Brightness, Greenness, Wetness, Fourth, Fifth and Sixth (Landsat 8 TOA)
- Descending and ascending SAR polarization indices(Sentinel-1 C-SAR)
- Slope and Elevation (SRTM)
- Height Above Nearest Drainage (Donchyts et al.)
- Precipitation (TerraClimate dataset)
- Temperature (ERA5-Land dataset)
- Canopy Interception (PML dataset)

ANALYSIS

Compute validation and testing accuracy, precision, recall, F1 and kappa score.

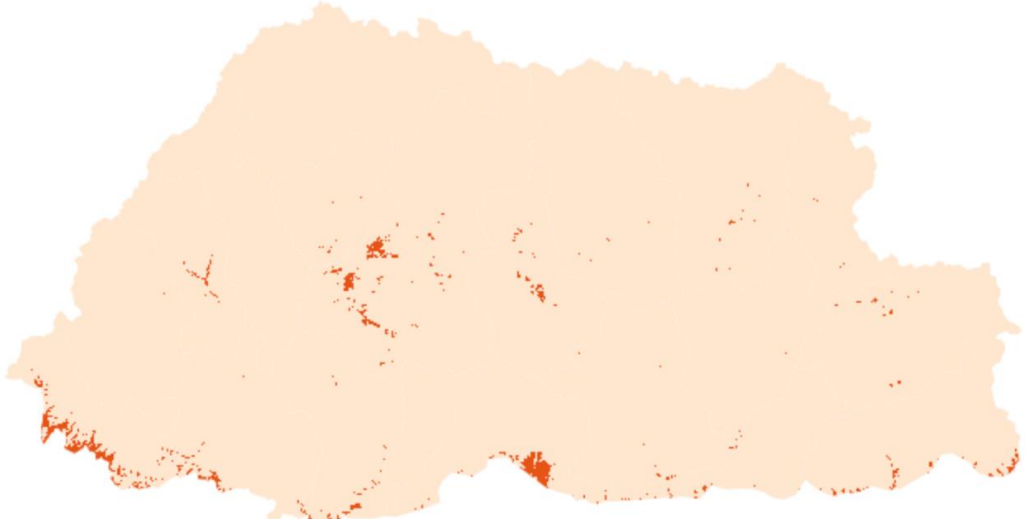
RESULTS

Rice crop masks on monthly basis

Aggregate monthly crops masks to produce an annual crop mask which is clipped using the RLCMS layer

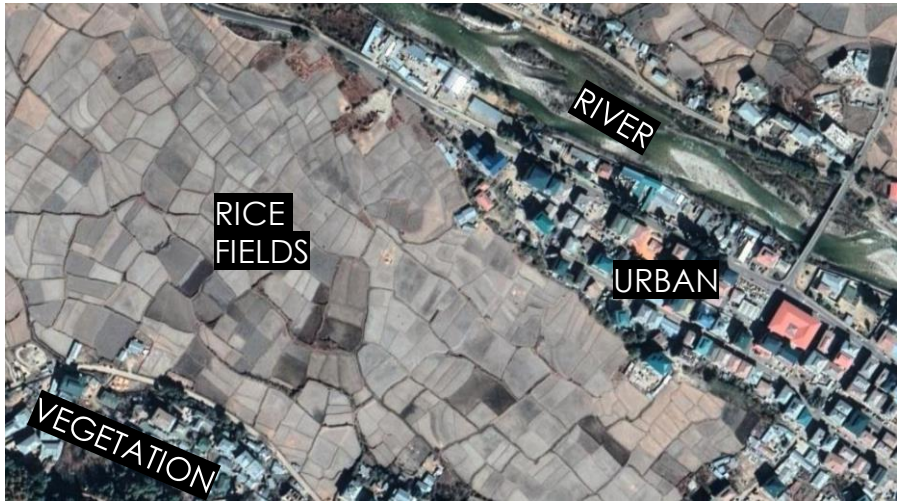
Develop GUI using crop mask to visualize trends in rice data

APPLYING RF MODEL



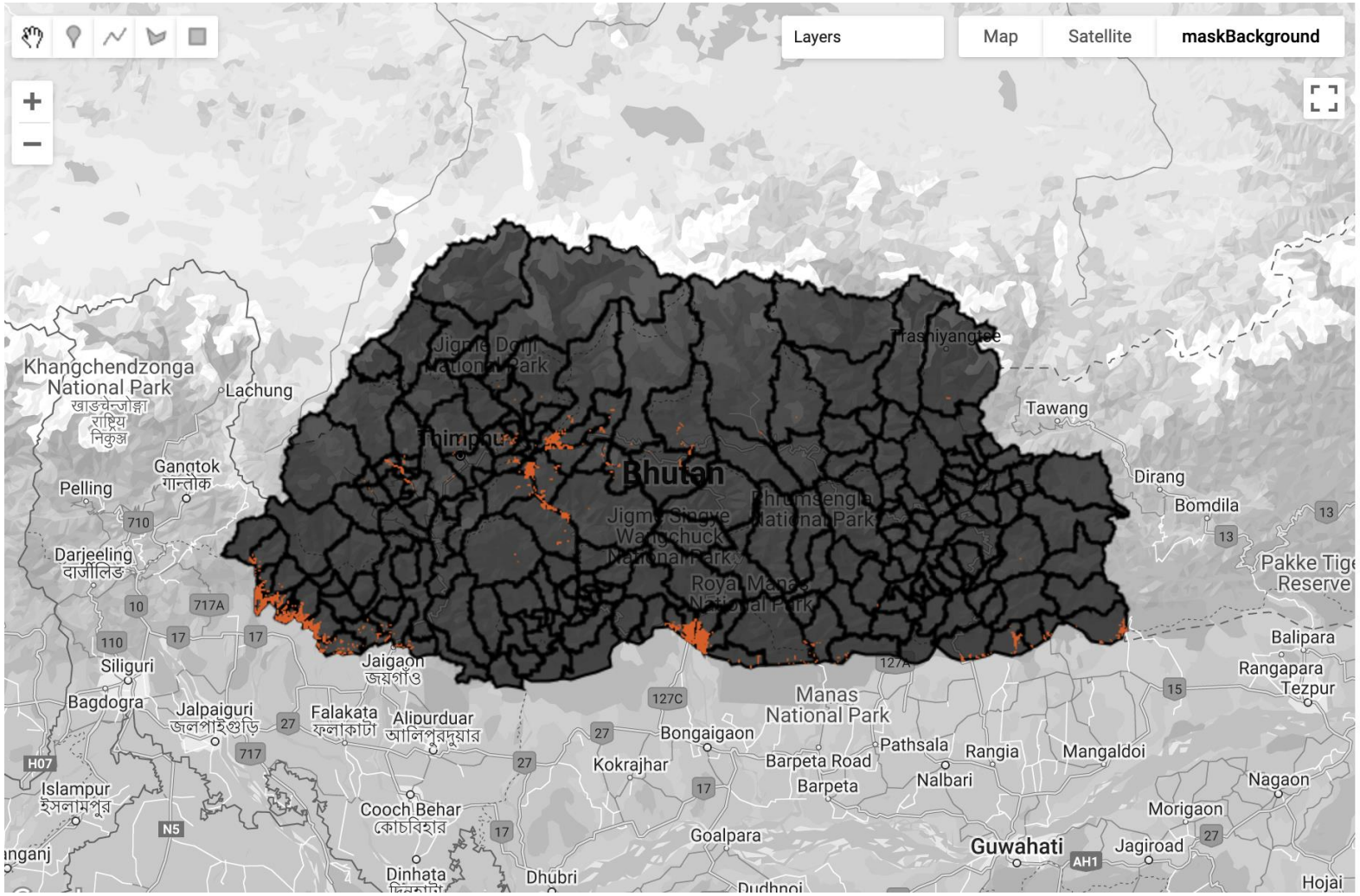
Aggregated Crop Mask

Non-rice areas



Rice Mask

GRAPHICAL USER INTERFACE



To get rice stats, first choose your region of interest

Select a Dzongkhag

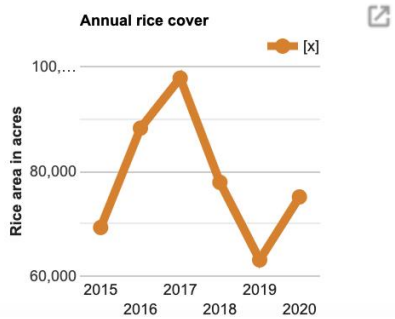
Select a Gewog

Or use your own asset as the area of interest (see Readme for how to load assets)

users/your_username/asset_name

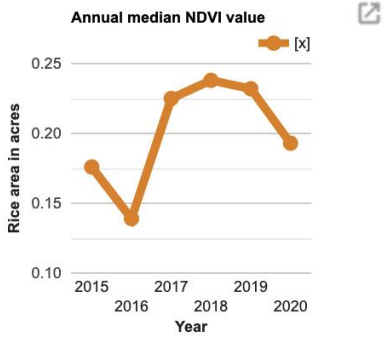
Select a reference year to generate crop mask layer in the view panel, rice distribution by regions and compare rice maps from other months to display trend in the loss or gain of rice area

Select a year

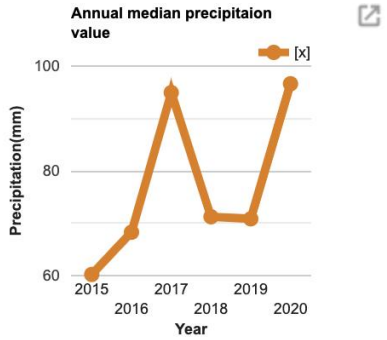


Total harvested rice area in Bhutan for 2015 according to DOA statistics: 49325acres

Predicted rice area in Bhutan for 2015: 69279acres



Median NDVI value in all of Bhutan for 2015: 0.176



CONCLUSIONS

Image Credit: Nidup Dorji

- Developed aggregated crop masks for each year from 2015 to 2020 using the random forest classifier
- Model predicted an increase in rice area from 2015 to 2017, but a gradual decrease until 2020
- Model predicted 2019 to have the lowest rice area of 63,098 acres and 2017 to have the highest rice area of 97,789 acres
- Capturing rice growing patterns in Bhutan requires a model that can capture points in diverse rice ecosystems across different altitudes
- Model had an average accuracy of 85.9% and kappa score of 71.8%

Thank you

NEXT UP DISASTERS