

An aerial photograph of a rural landscape, likely in the Midwest, showing a patchwork of agricultural fields. A white grid is overlaid on the image, representing the Sentinel-2 satellite imagery. A winding road or river is visible in the lower-left quadrant. The text is overlaid on the top half of the image.

# Toward A Scalable Agricultural Classification Model: Sentinel-2 Imagery Pipeline for Field Delineation

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# Project Overview

**Goal:** Build a Python workflow to extract ag field boundaries from Sentinel-2 imagery for the whole planet

- **Core Questions:**

- How much *imagery data* (really, how little) is necessary to return accurate field boundary polygons?
- What *methods* produce accurate field boundary segmentation most efficiently?

- **Balance accuracy and processing:**

- Global scope: Flexible & Scalable
  - Computationally Efficient Methods & Design
-



# Scalable and Flexible to handle different ag types



**Starting with this.**

Red River Valley,  
MN

- 
- **Fields** are the operational unit of agriculture, critical for understanding impacts of climate change on ag
  - **Global** agriculture estimates are too coarse or too slow
  - **Local** analysis is not scalable

**Why?**



An aerial photograph of a landscape featuring a complex, winding river or canal system that meanders through a patchwork of agricultural fields. The fields are divided into numerous small, irregular plots, each with a different color, suggesting various crops or land uses. The river is a dark, sinuous line that cuts through the lighter-colored fields. The overall scene is a mosaic of natural and human-made elements.

# How?

Bridge the gap between global  
and local by combining high-res  
imagery with HPC infrastructure  
and methods

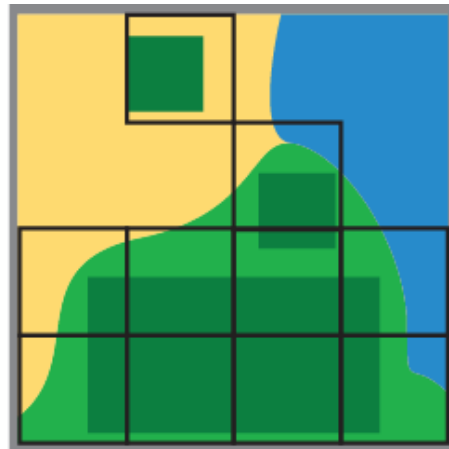
# Conceptual Workflow



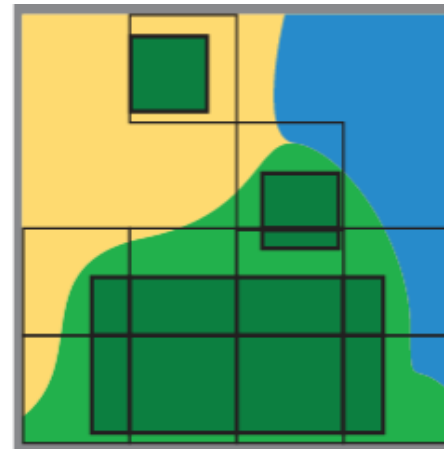
All Tiles



Drop Tiles w/o Crops



Drop Pixels w/o Crops

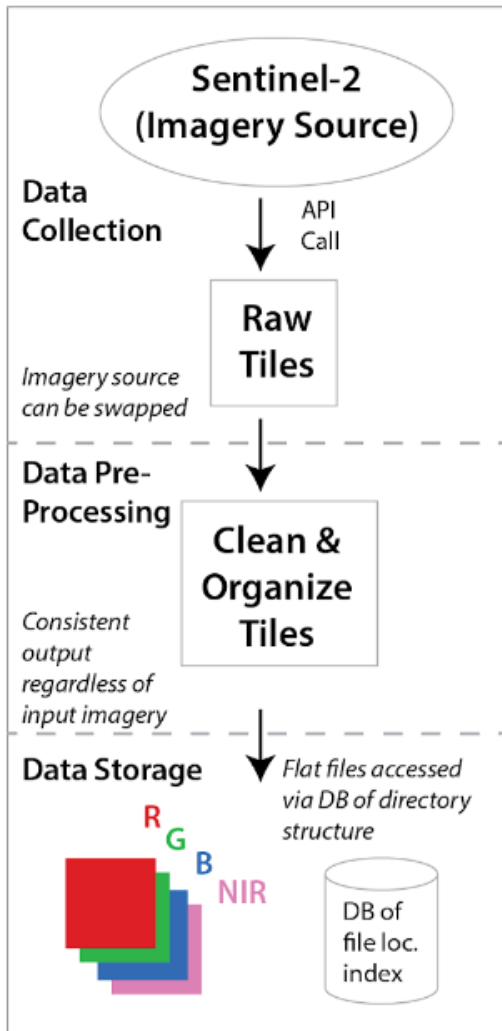


Perform Segmentation

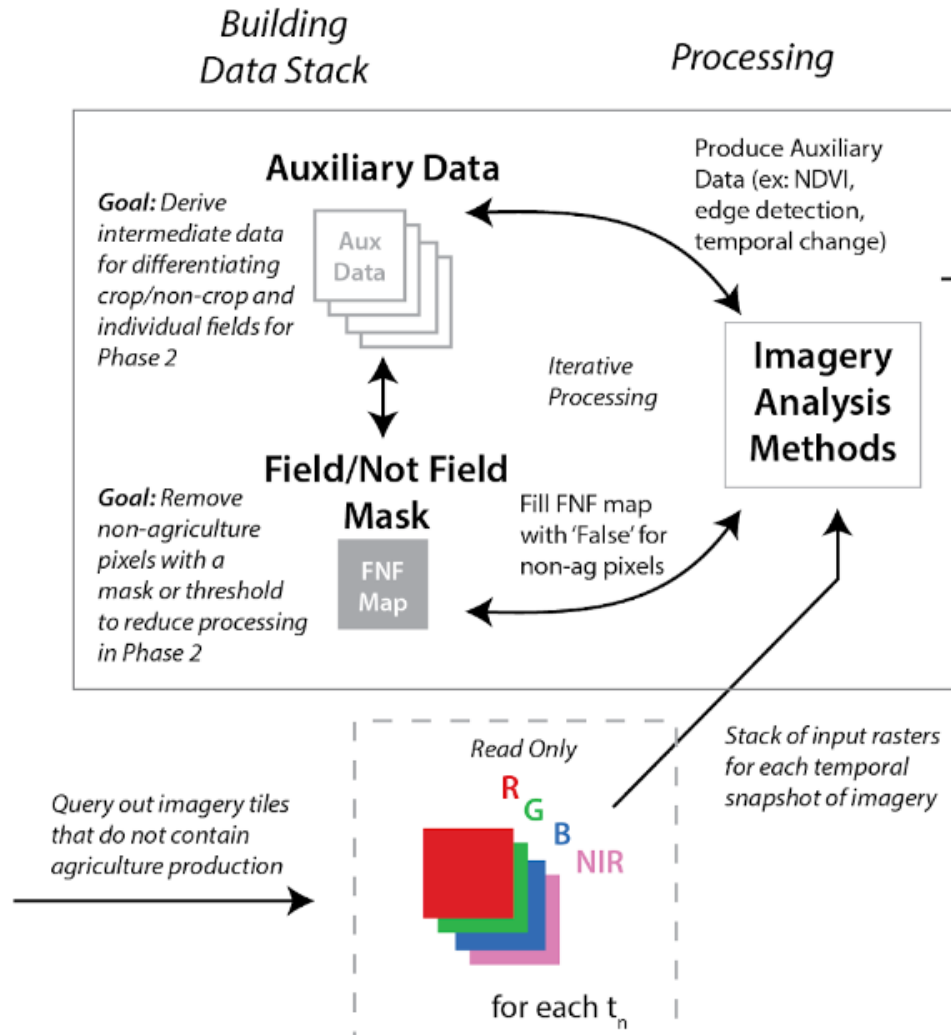


# Conceptual Workflow

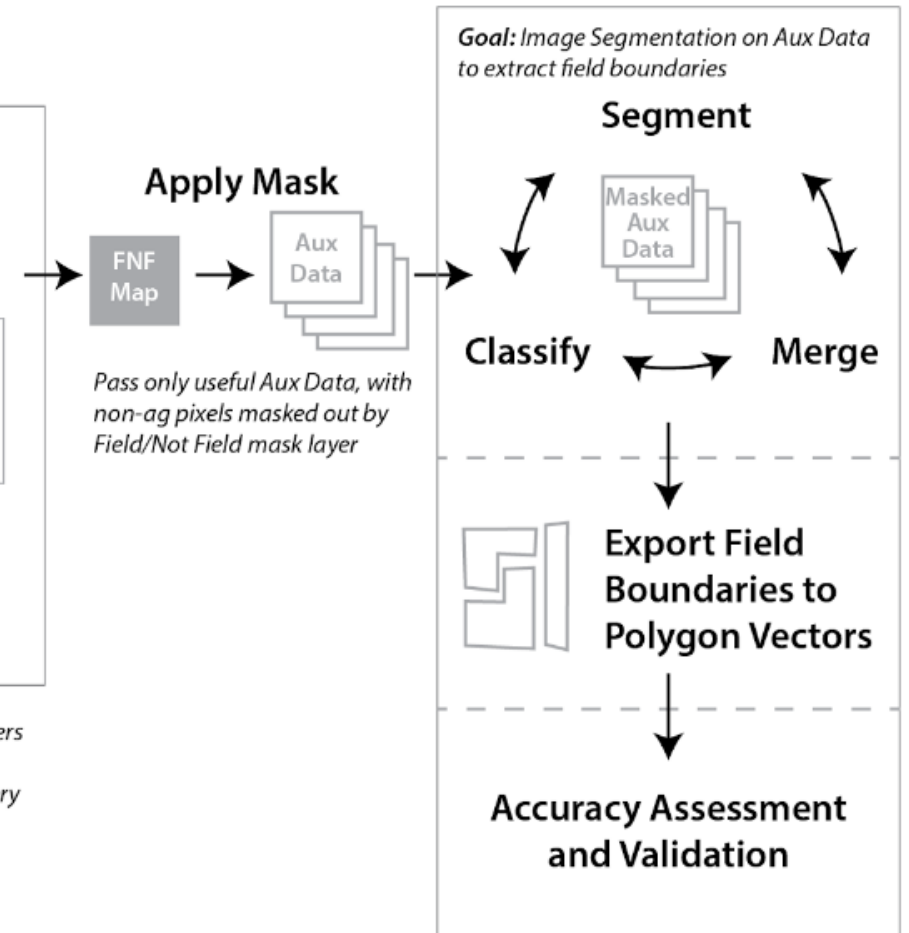
## Data Collection Pipeline



## Phase 1 - Intermediate Data Processing

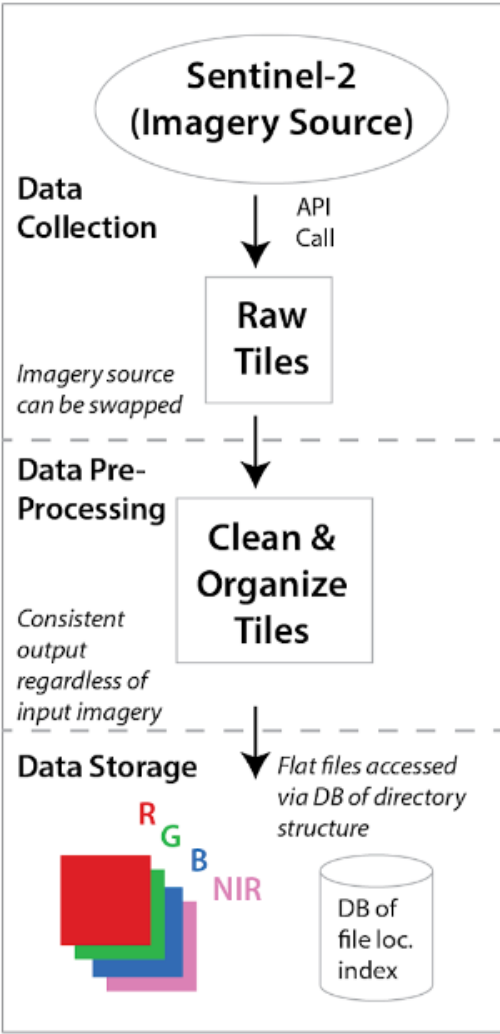


## Phase 2 - Image Segmentation

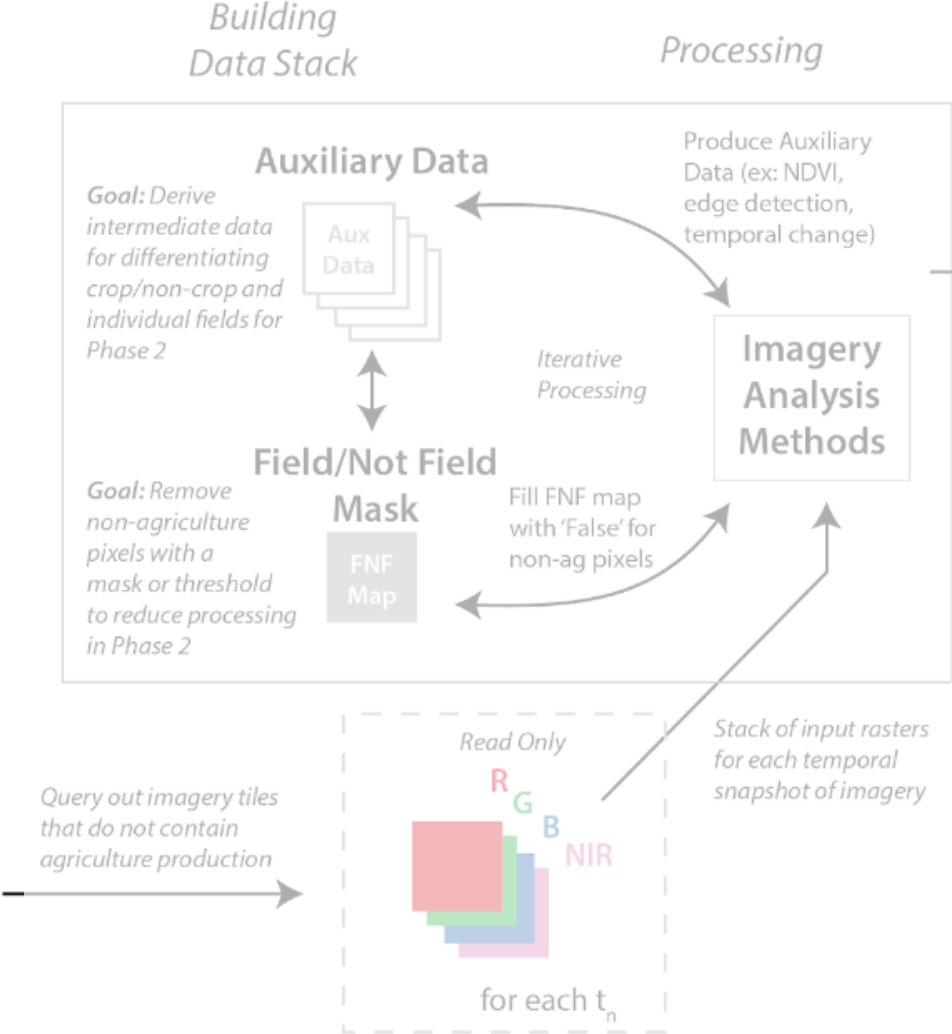


# Conceptual Workflow

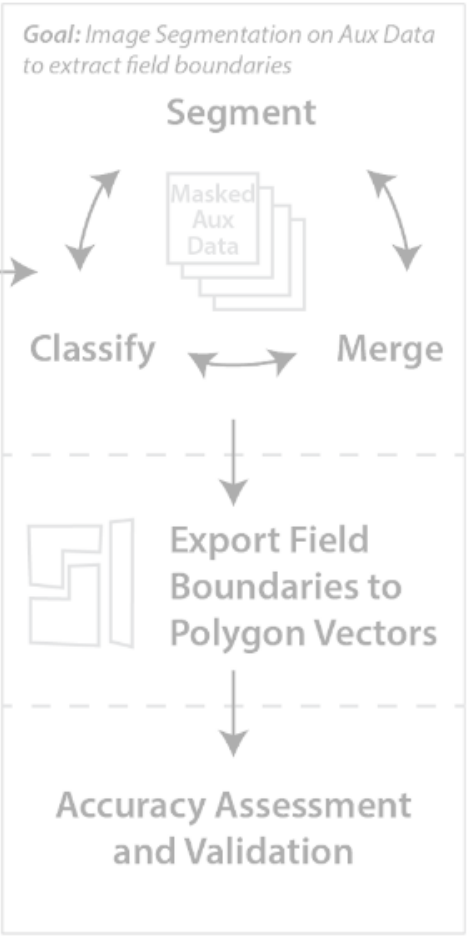
## Data Collection Pipeline



## Phase 1 - Intermediate Data Processing



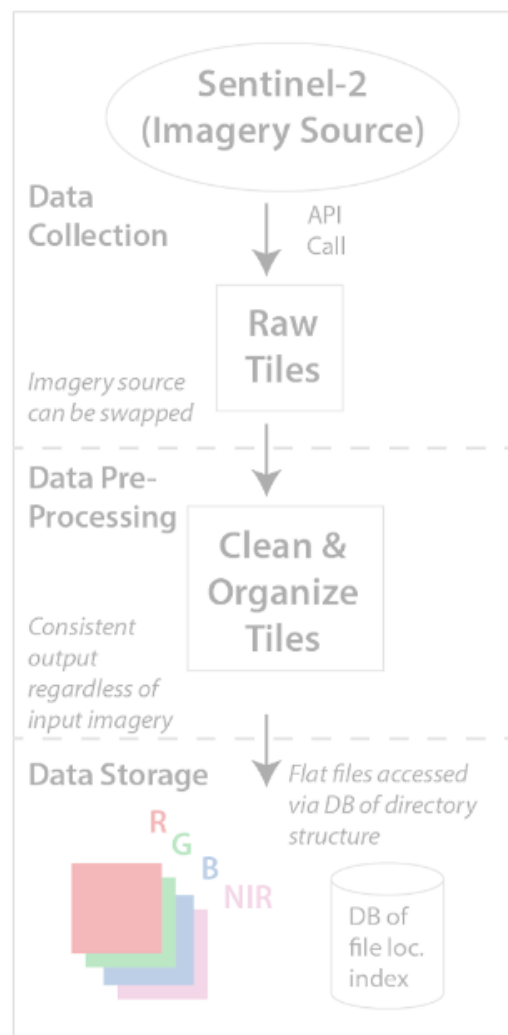
## Phase 2 - Image Segmentation



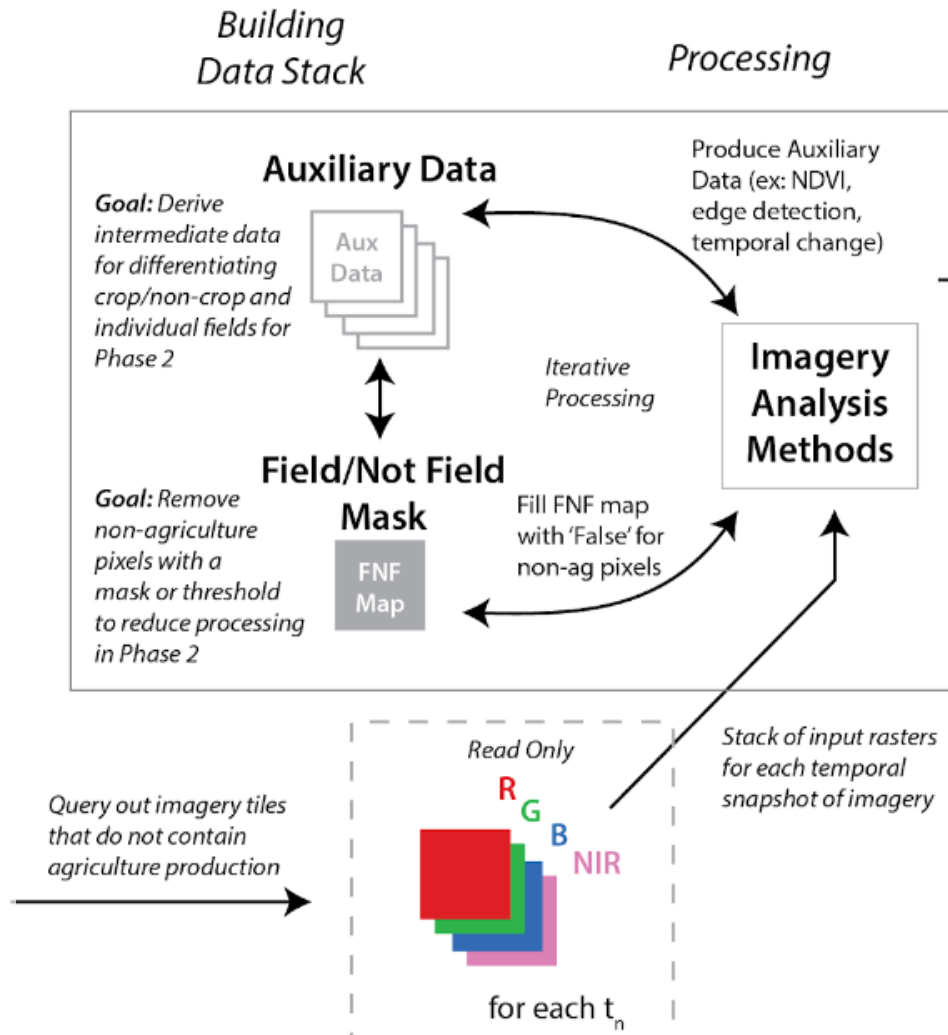


# Conceptual Workflow

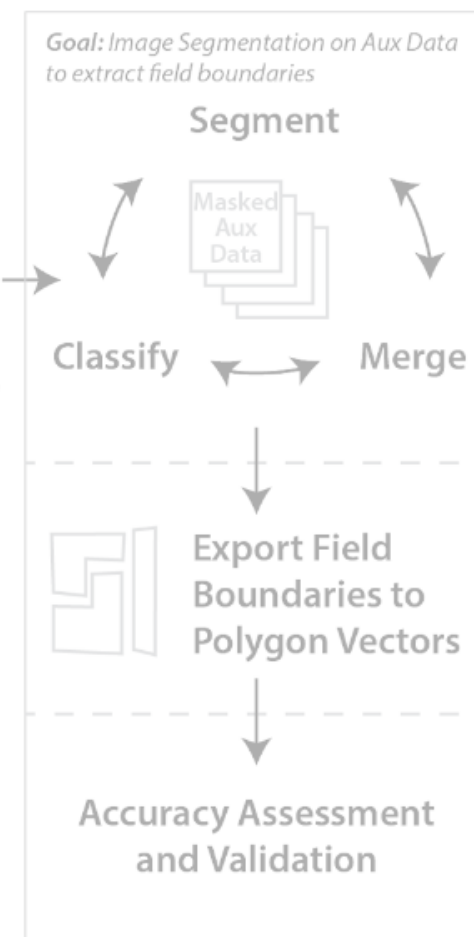
## Data Collection Pipeline



## Phase 1 - Intermediate Data Processing

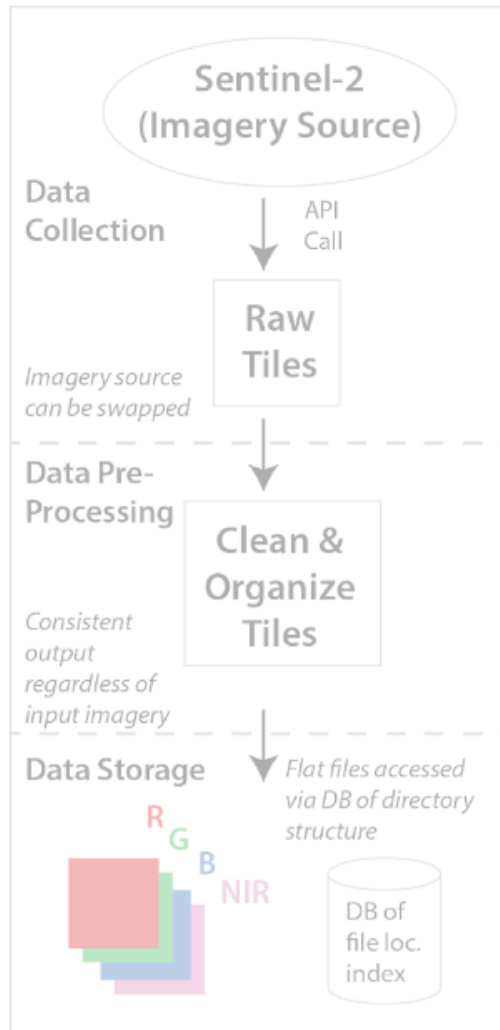


## Phase 2 - Image Segmentation

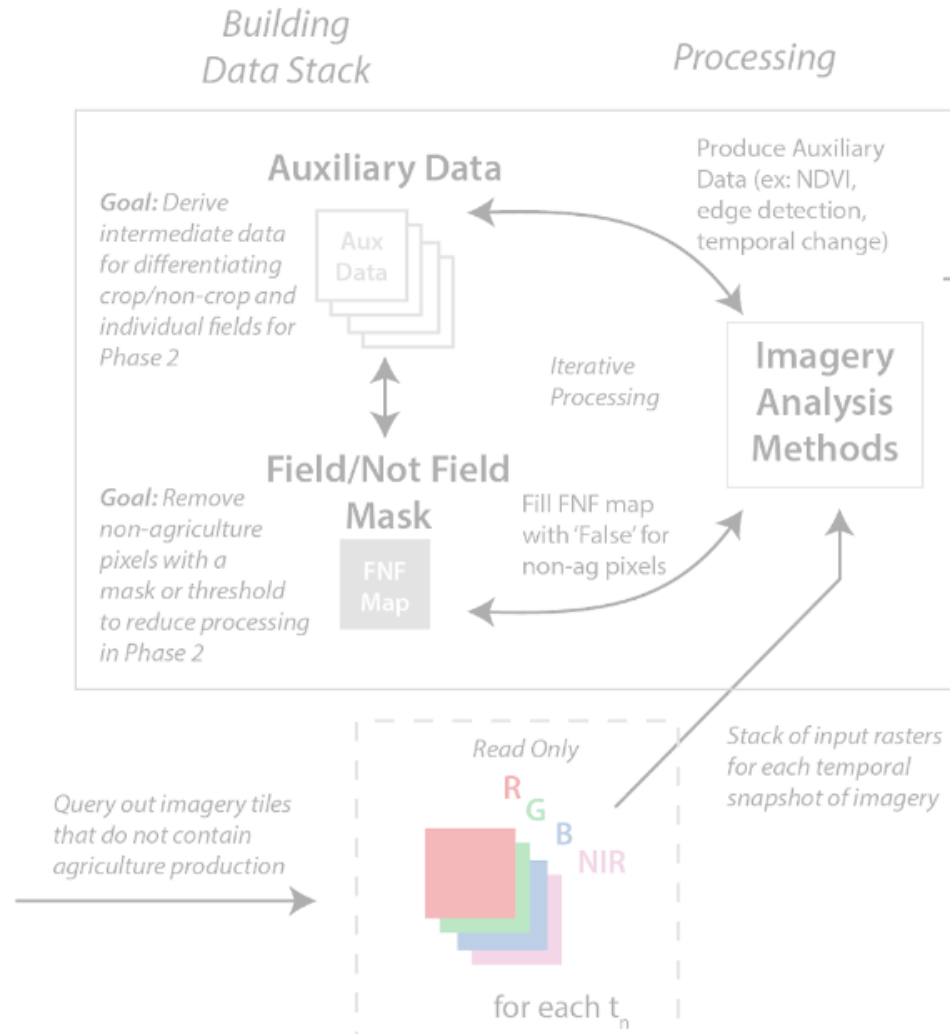


# Conceptual Workflow

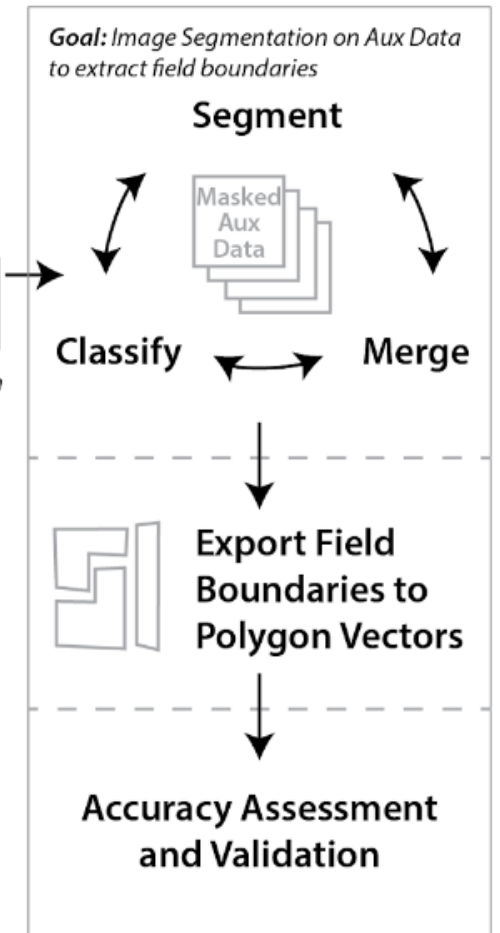
## Data Collection Pipeline



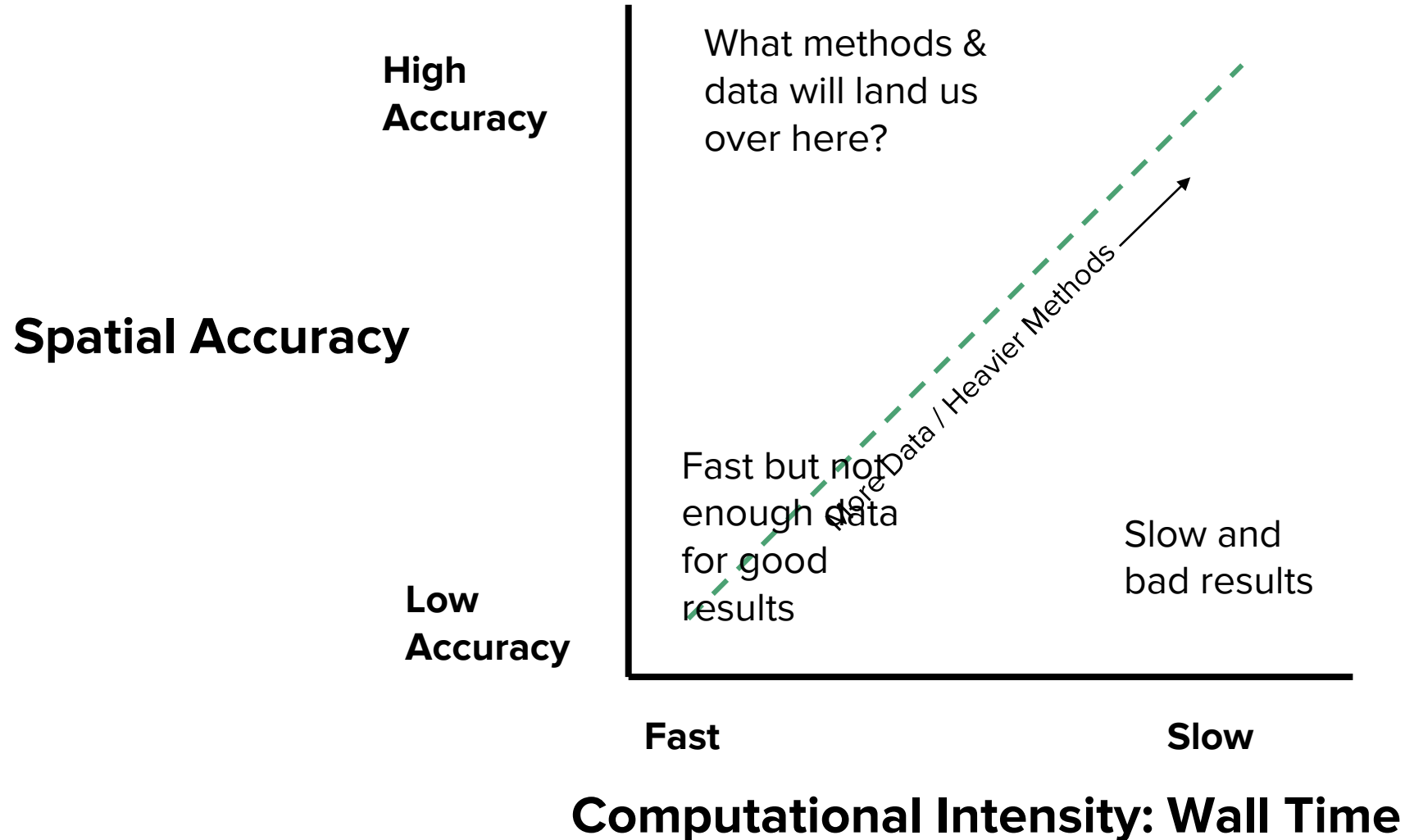
## Phase 1 - Intermediate Data Processing



## Phase 2 - Image Segmentation



# Trade-offs: Speed and Accuracy





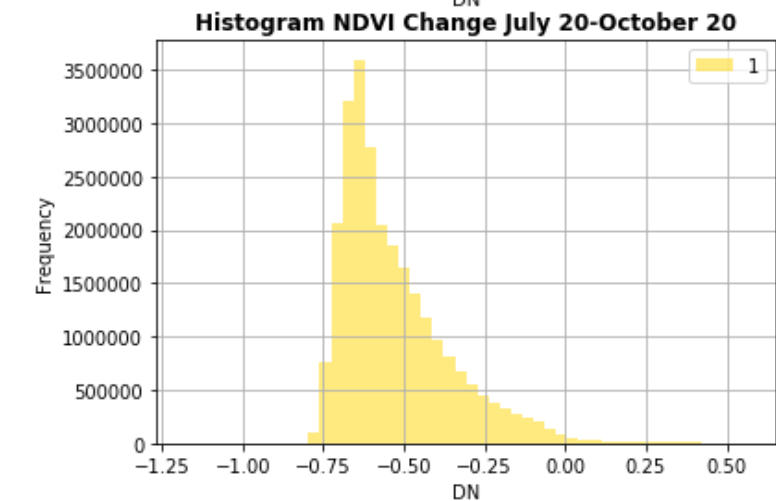
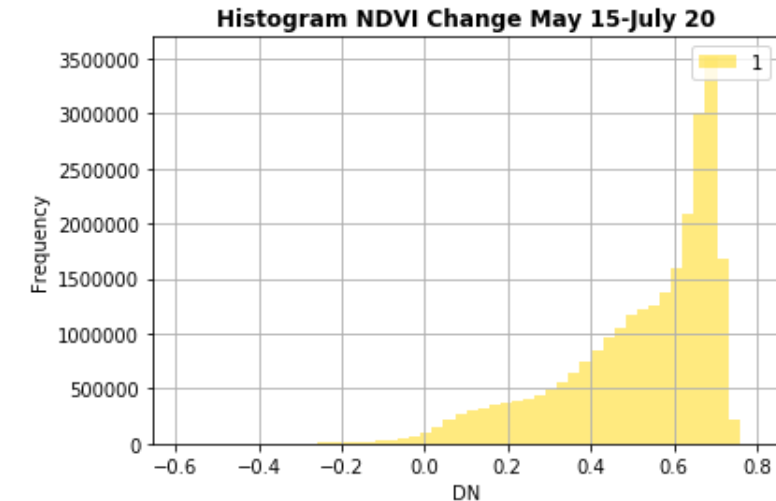
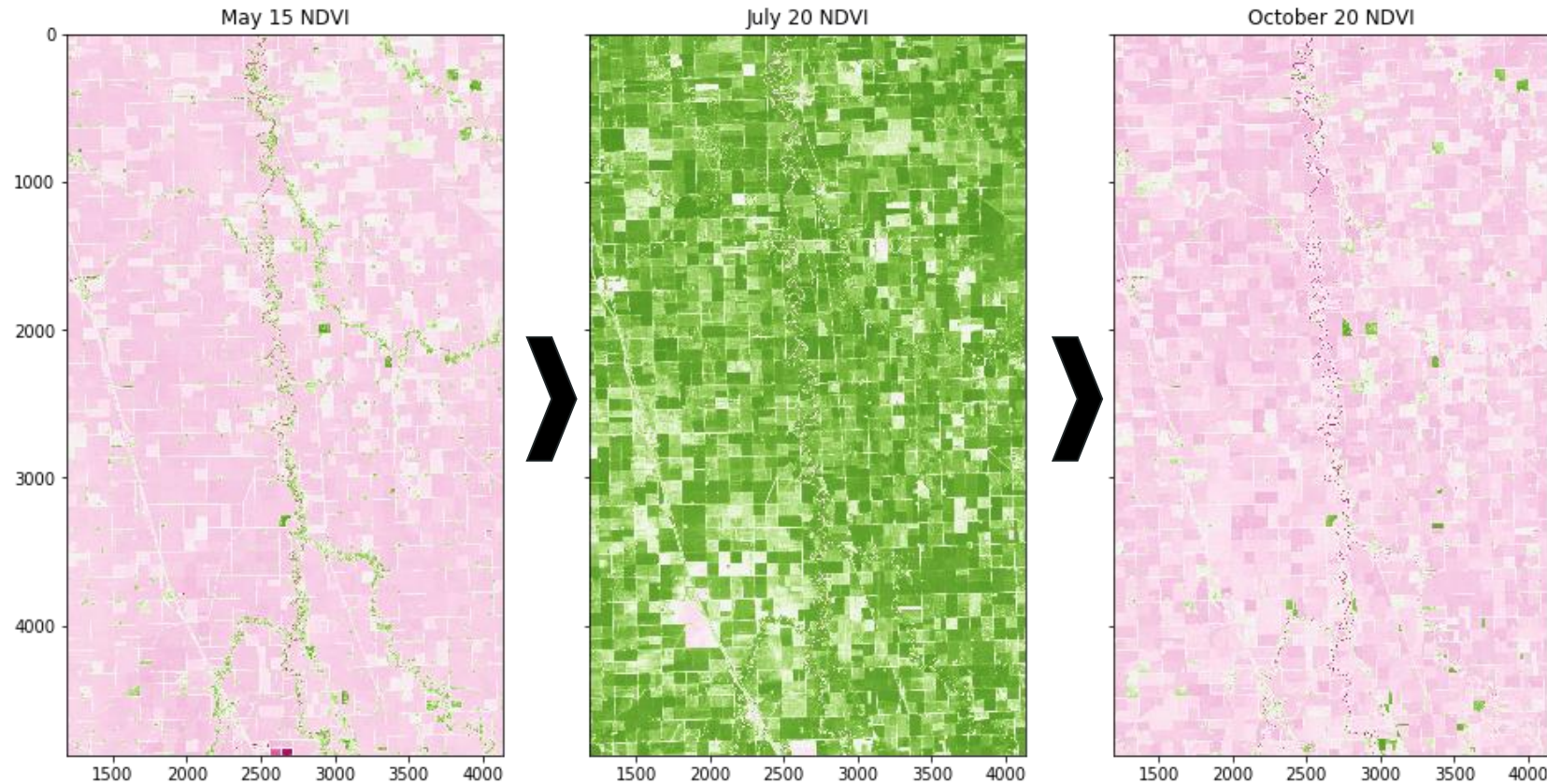
**Next Step:  
Methods Testing**

**Preliminary Study Area:**  
Red River Valley, MN



# Intermediate Data Processing

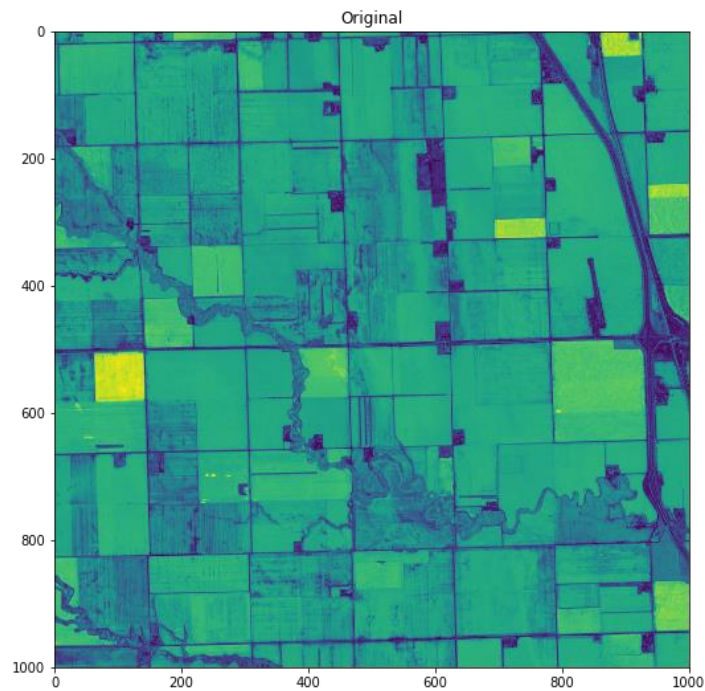
## Example: NDVI Change



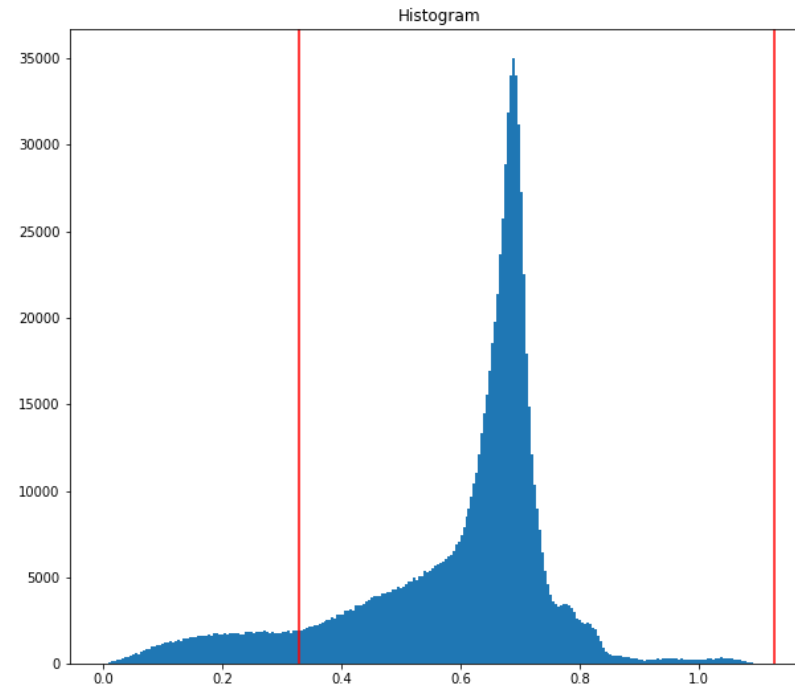


# Cumulative NDVI Change to Show Crop vs. Non-Crop

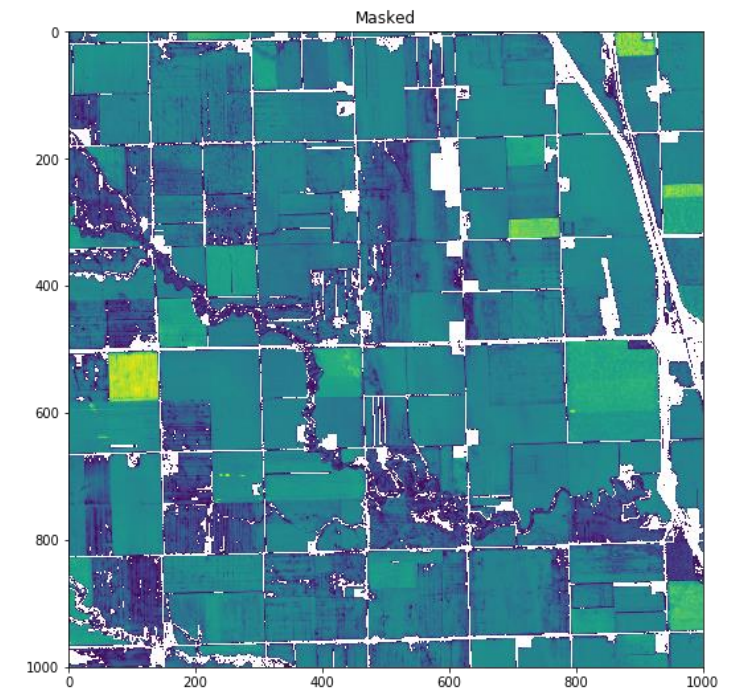
NDVI Change



Mask out pixels  
(ex: bottom 10%)



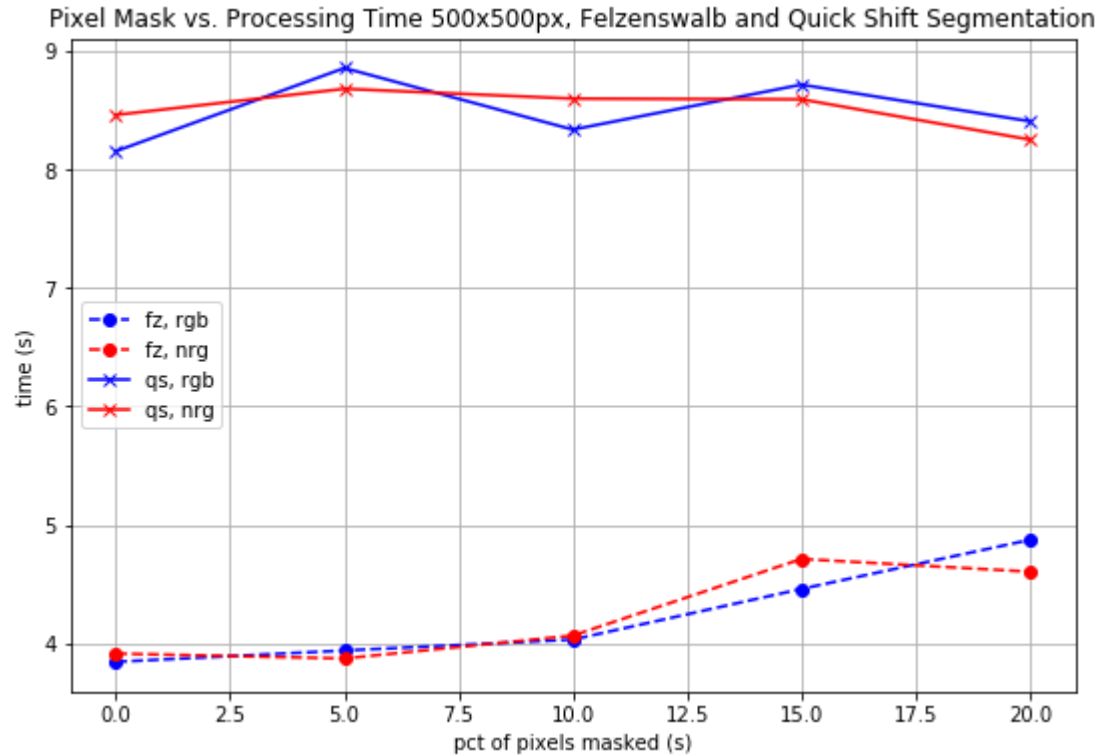
Pass mask to  
segmentation



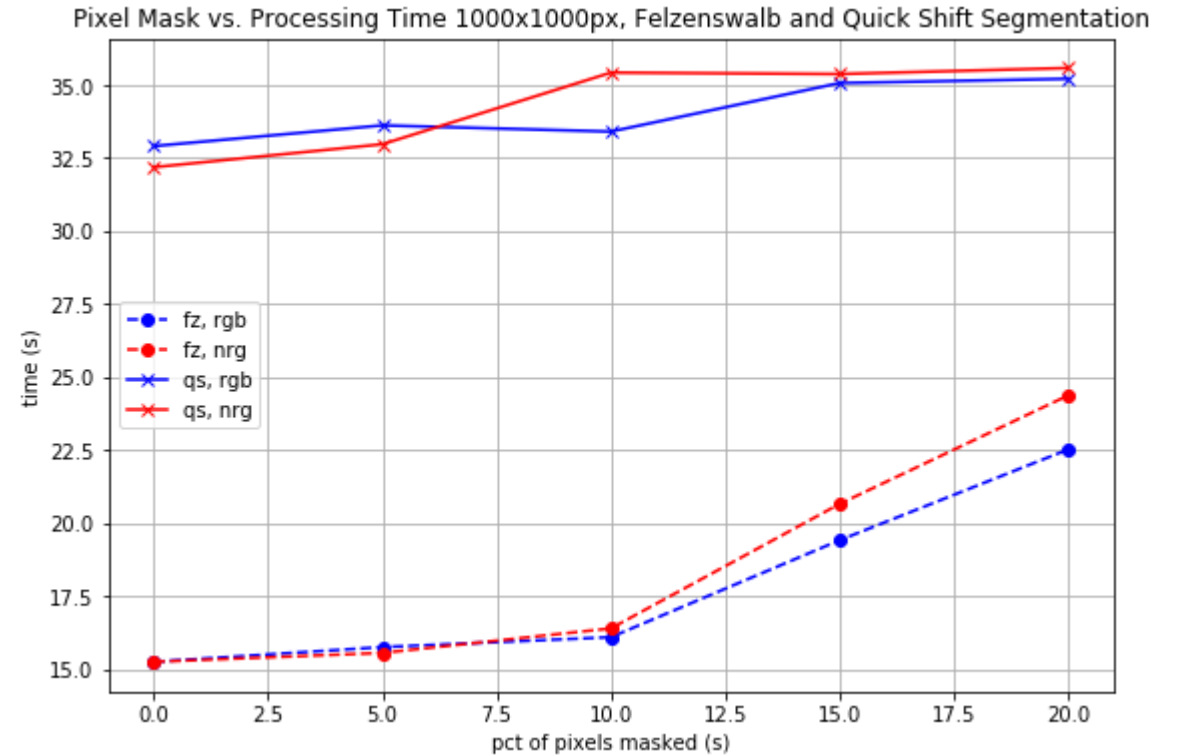


# Masking doesn't necessarily improve processing speed

## 500x500 pixel image



## 1000x1000 pixel image



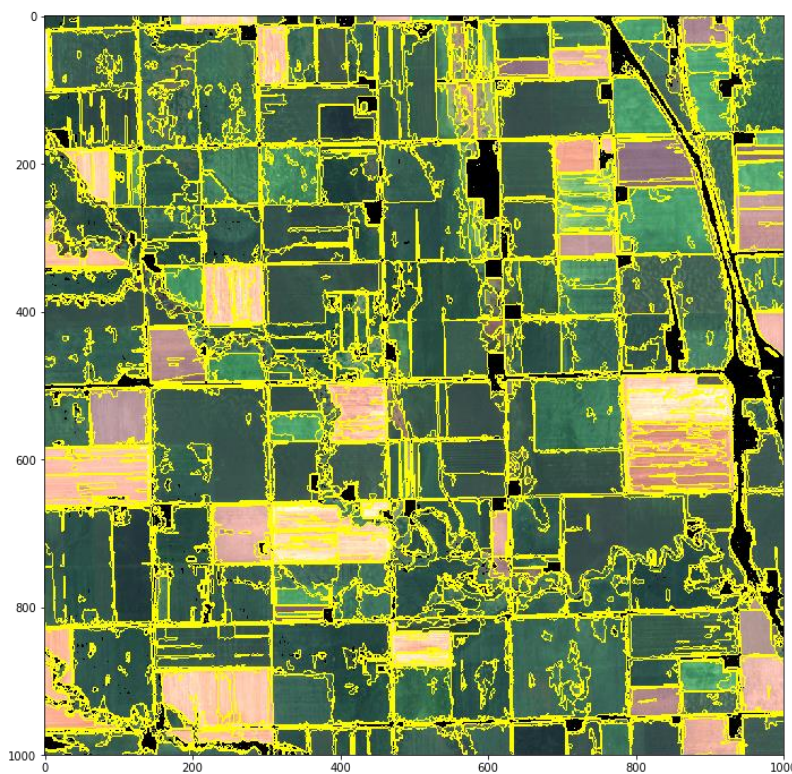
More testing will be needed at scale

# But it does help with edge detection

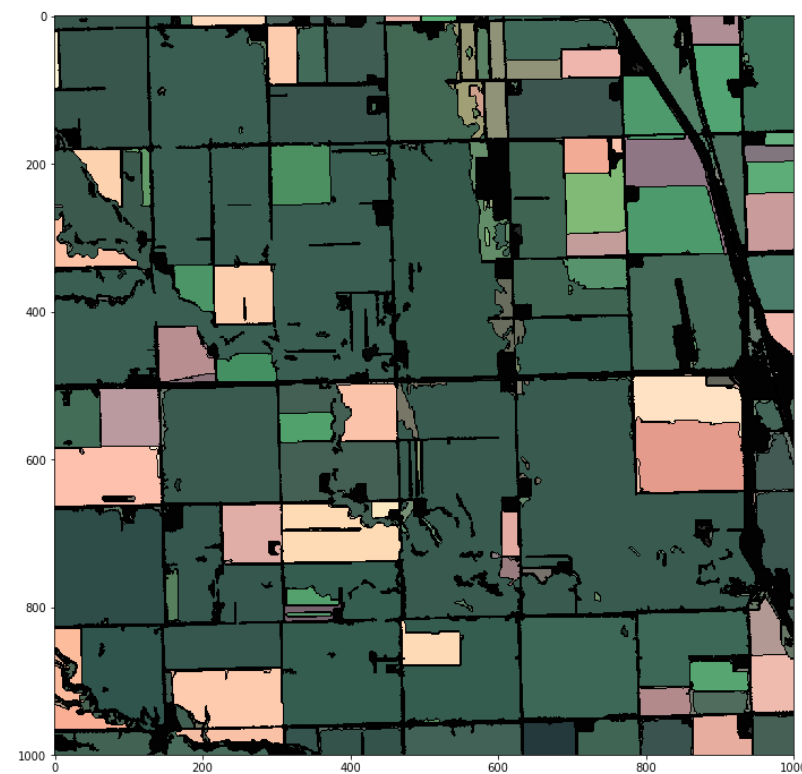
RGB Image (no mask)



Segmentation (with mask)

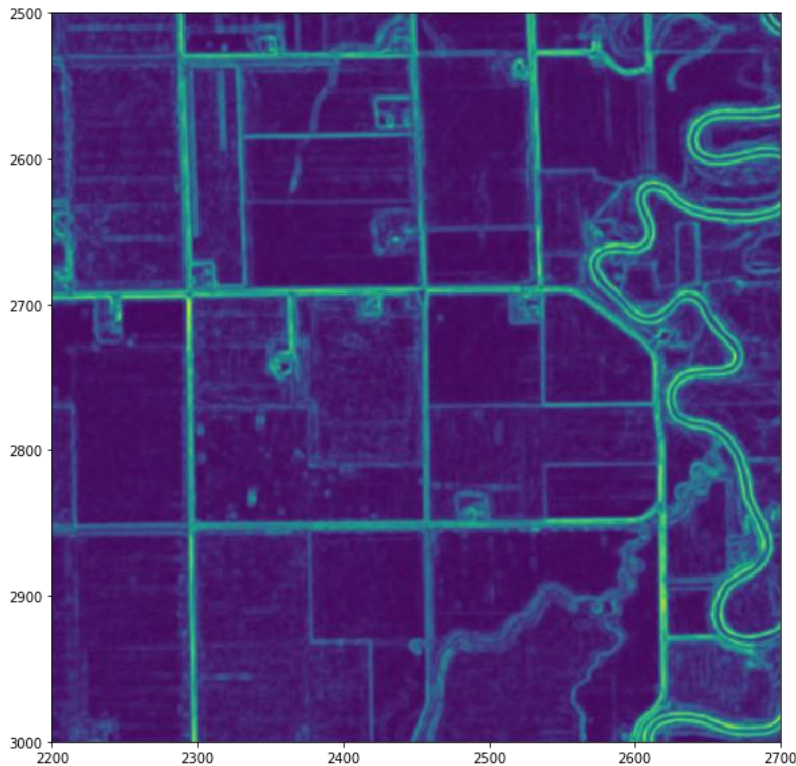


Merge Labels

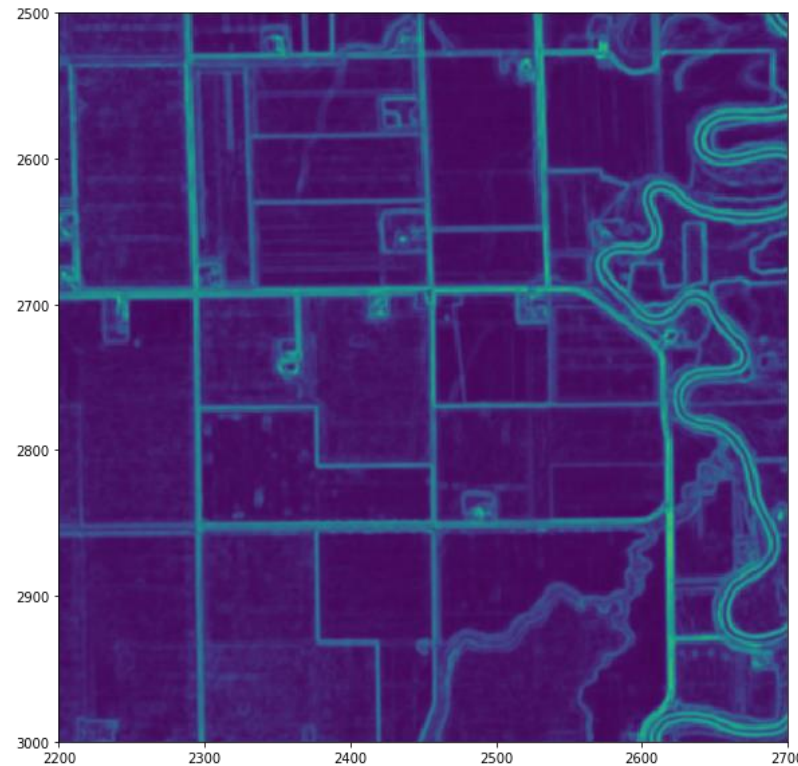


# Temporal Imagery for Edge Detection

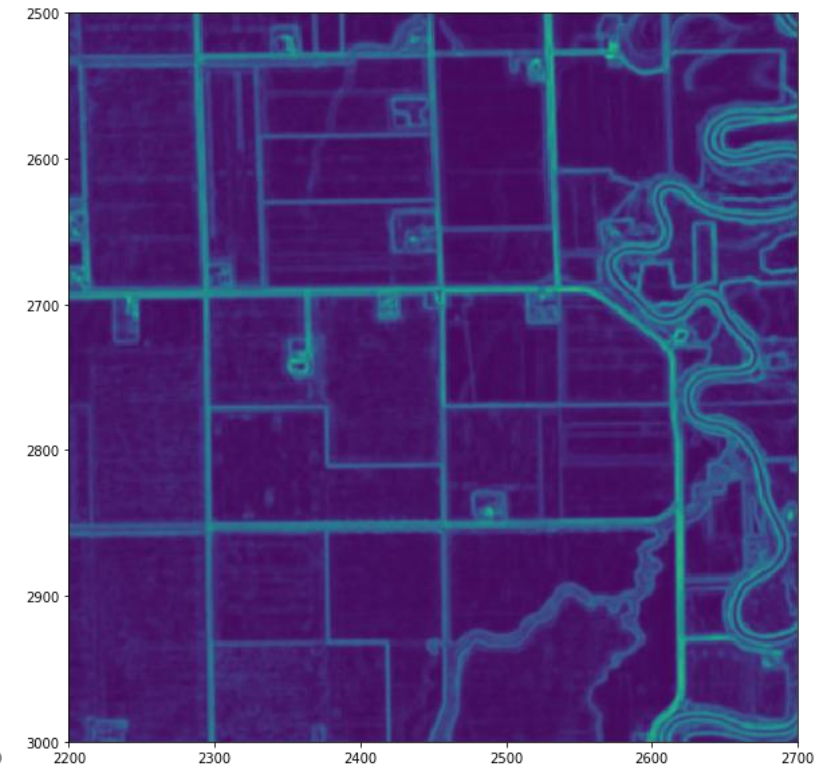
1 Image (24 sec)



3 Images (55 sec)




5 Images (93 sec)



Method: Watkins & van Niekirk, 2019



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- An aerial photograph of a rural landscape, likely in Minnesota, showing a patchwork of agricultural fields in various shades of green, brown, and yellow. A winding road or river is visible on the left side. A semi-transparent dark rectangle is overlaid on the left side of the image, containing a bulleted list of text.
- **Validation and spatial accuracy assessment**
  - **Apply the framework: model experiments for MN**
  - **Sensitivity testing**

## **Next Steps**



An aerial photograph of a rural landscape, likely in a European country, showing a dense grid of agricultural fields in various shades of green, brown, and purple. A winding, light-colored road or path runs vertically through the center of the image. The text "Questions?" is overlaid in white on the left side.

**Questions?**

**Thanks!**