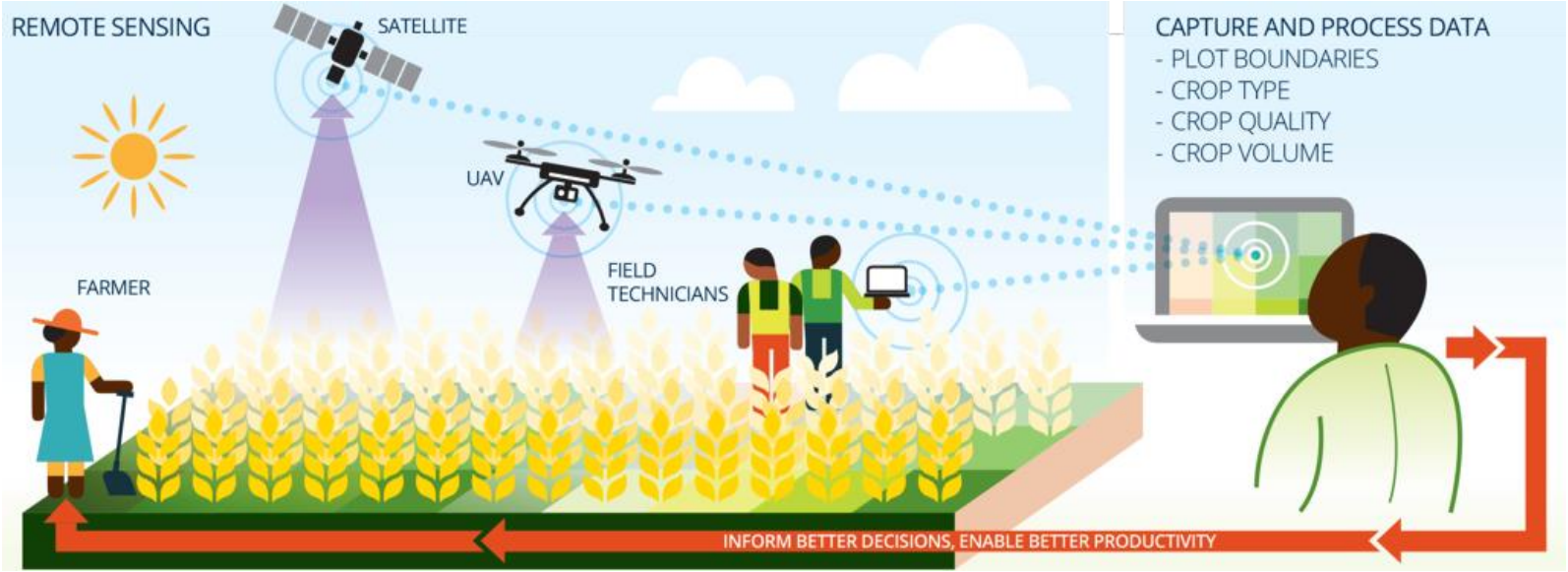
sUAS for Mapping and Monitoring Smallholder Farms in Tanzania

Jyothy Nagol, Jan Dempewolf, and Sixbert Maurice
(University of Maryland College Park)

AgriSense Africa

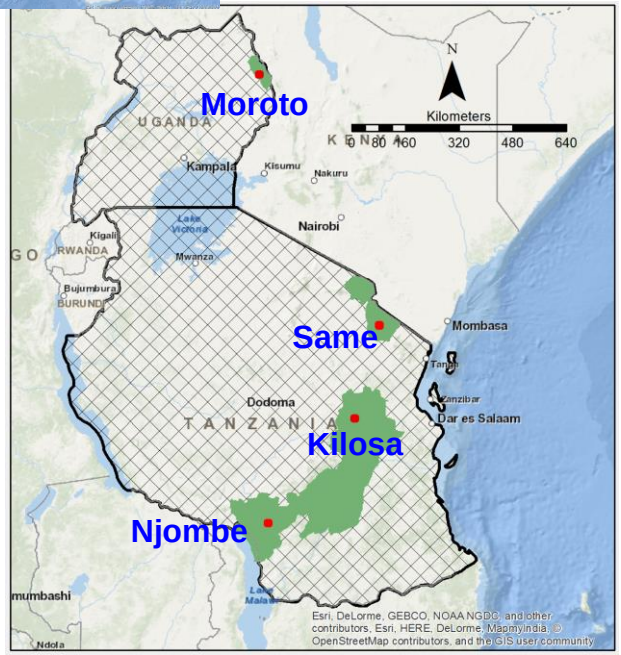
- Part of an international initiative to explore ways to use remote sensing technology to improve agricultural practices in Sub-Saharan Africa and South Asia.
- The project aims to use Remote Sensing Technologies to:
  - Improve agricultural monitoring
  - Improve food security forecasting

Rationale for UAVs



- UAVs are being explored to
  - Linking the Ground and Space-borne data
  - Use in lieu of remote sensing data

Study Area



- ❏ UAV data collected at Tanzanian sites only
- ❏ Data collection started in March (pilot stage)
- ❏ Monthly repeat coverage of 1km2 area
- ❏ Sites have been chosen to represent the agricultural productivity gradient in Tanzania
  - ❏ Same: Low
  - ❏ Kilosa: Medium
  - ❏ Njombe: High
- ❏ Smallholder, subsistence farming
- ❏ Crop boundaries change every season
- ❏ mixed and Intercropping is common

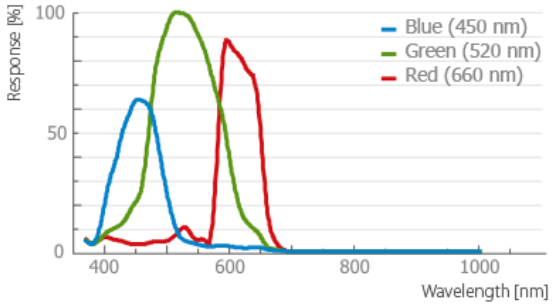
sUAS being Deployed

- Fixed Wing: senseFly eBee
  - Endurance: ~25 to 35 minutes
  - Weight: ~700 grams
  - Sensors
    - Modified canon s110 cameras
    - Custom Multispectral camera

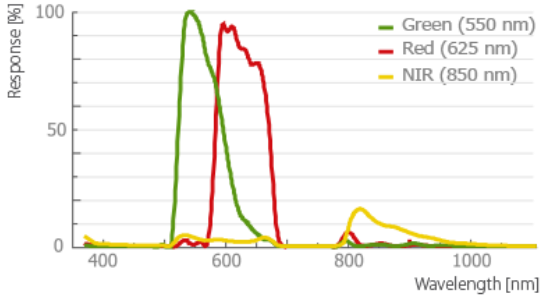
- Multi-rotor: Geo-Konzept x8000
  - Endurance: ~20 minutes
  - Sensors
    - 5 channel Multispectral camera
    - RGB camera (Sony Nex 7)

Sensors for senseFly eBee

RGB camera

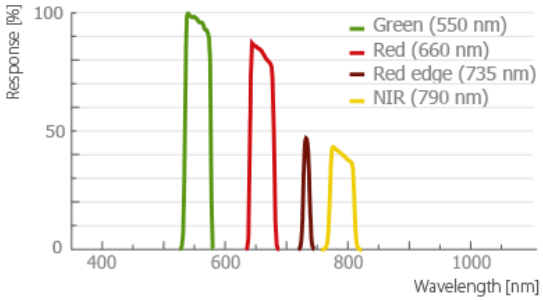


NIR camera



MultiSpec 4c

(With onboard calibration data)

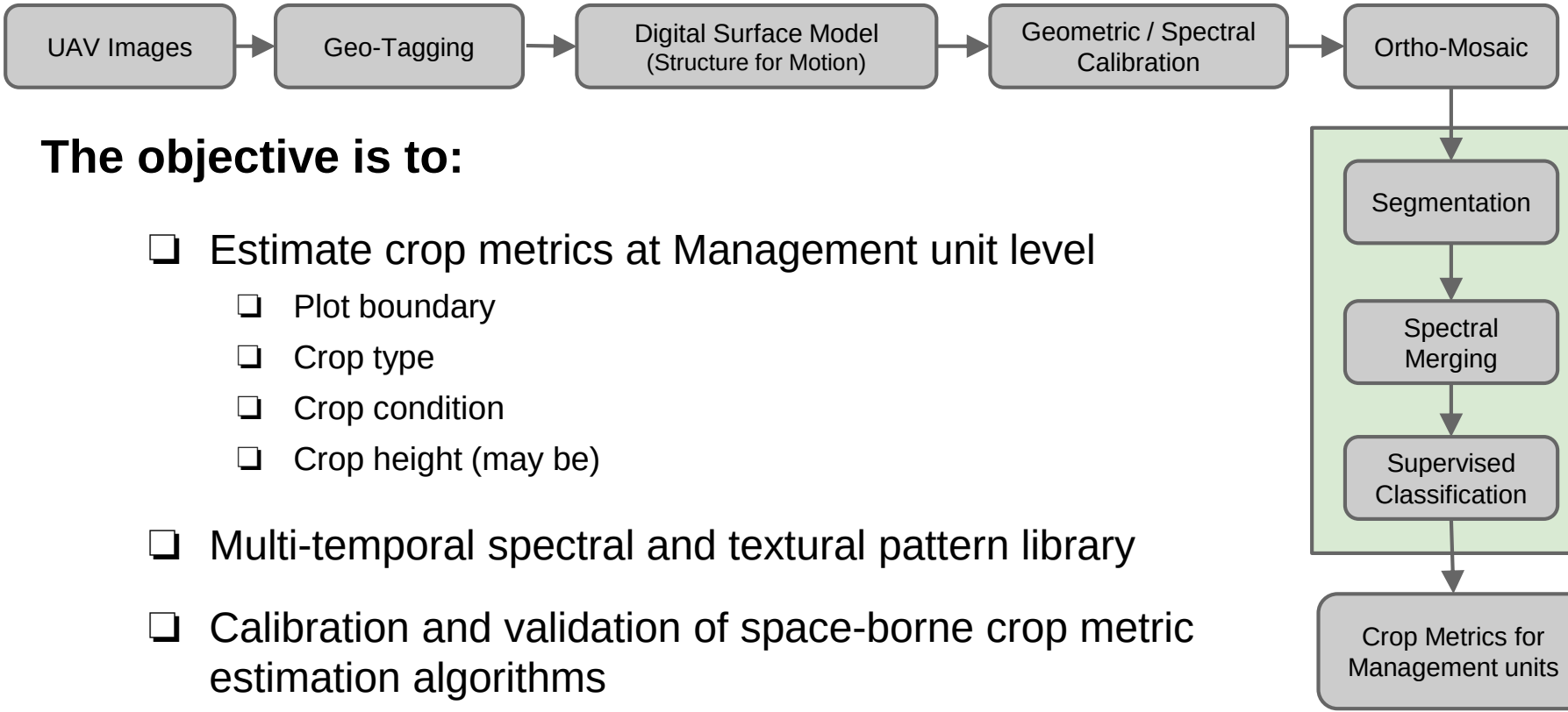


Sensors for X-8000

TetraCam 6-Channel Mini MCA

- Spectral Bands
  - Band 1: 550 nm (Green)
  - Band 2: 680 nm (Red)
  - Band 3: 710 nm (Red-Edge)
  - Band 4: 740 nm (Red-Edge)
  - Band 5: 800 nm (NIR)
  - Band 6: Incident Light Sensor (ILS)
- On-board calibration data

Workflow

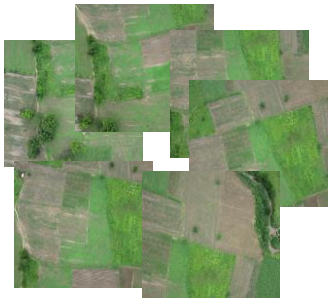


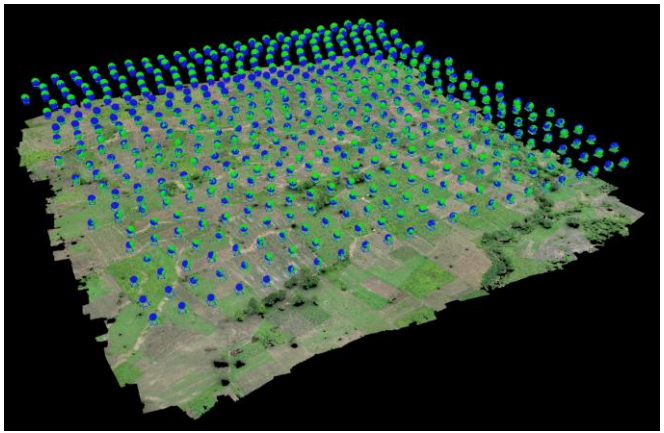
The objective is to:

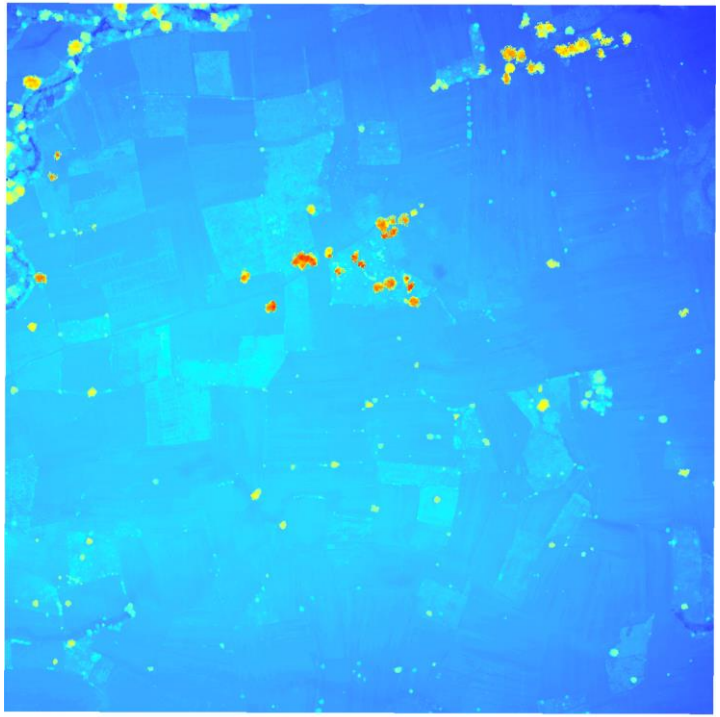
- ❏ Estimate crop metrics at Management unit level
  - ❏ Plot boundary
  - ❏ Crop type
  - ❏ Crop condition
  - ❏ Crop height (may be)
- ❏ Multi-temporal spectral and textural pattern library
- ❏ Calibration and validation of space-borne crop metric estimation algorithms

Workflow

UAV Images → **Geo-Tagging** → **Digital Surface Model** (Structure for Motion) → Geometric / Spectral Calibration → Ortho-Mosaic







Object Based Image Analysis

- Segmentation
- Spectral Merging
- Supervised Classification

→ Crop Metrics for Management units

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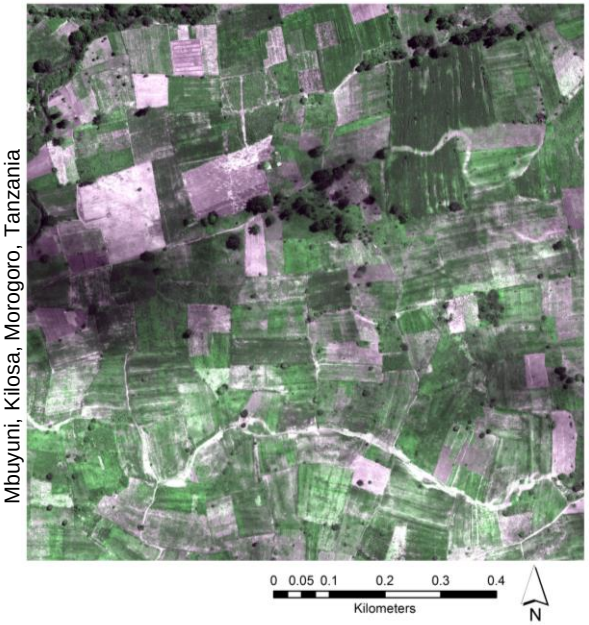
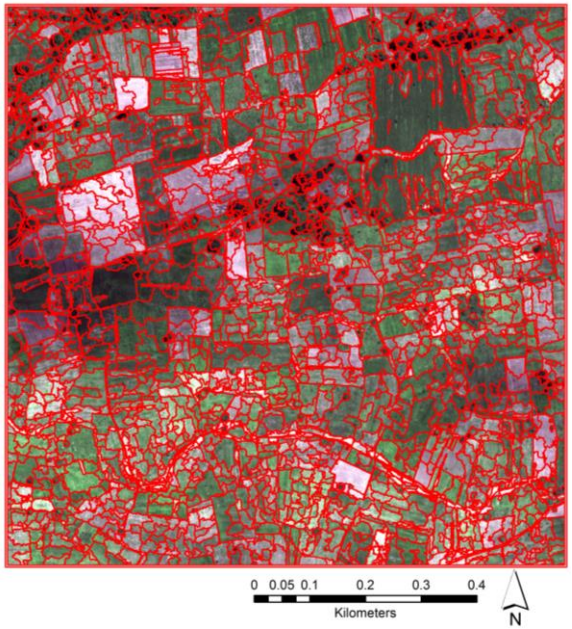




Object Based Image Analysis

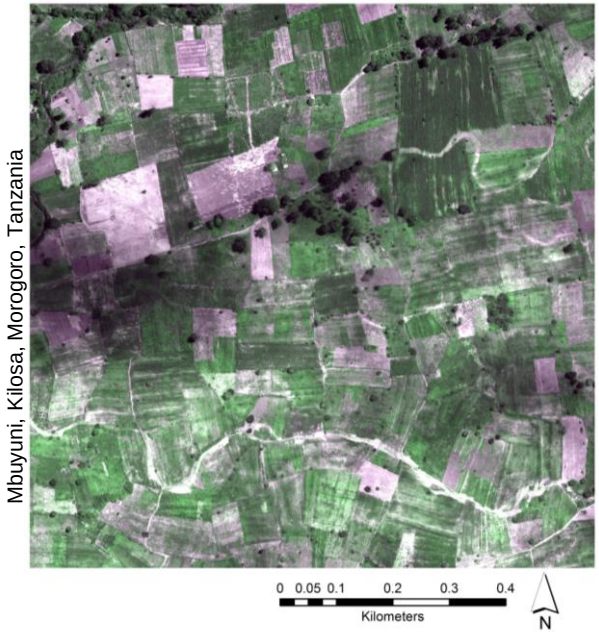
- **Segmentation**
- Spectral Merging
- Supervised Classification

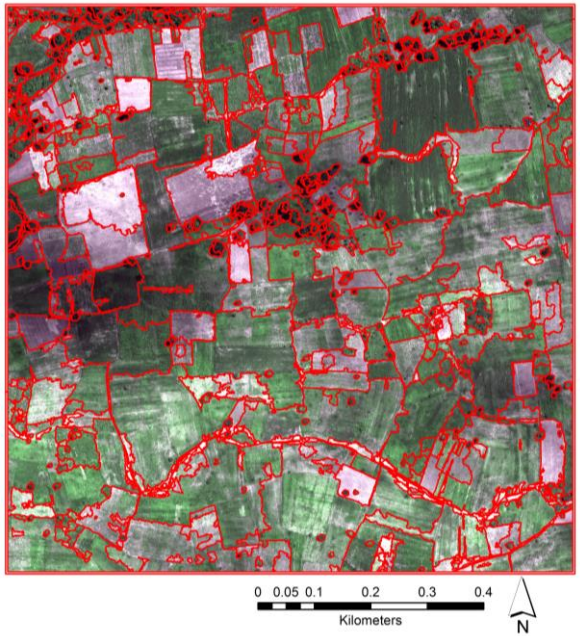
Crop Metrics for Management units

- Segmented orthomosaics created using ~500 images from the Cannon S110 camera on board senseFly eBee.

Workflow

UAV Images → Geo-Tagging → Digital Surface Model (Structure for Motion) → Geometric / Spectral Calibration → Ortho-Mosaic





Object Based Image Analysis

- Segmentation
- **Spectral Merging**
- Supervised Classification

Crop Metrics for Management units

- Spectrally Merged segments for identification of active farms

Workflow

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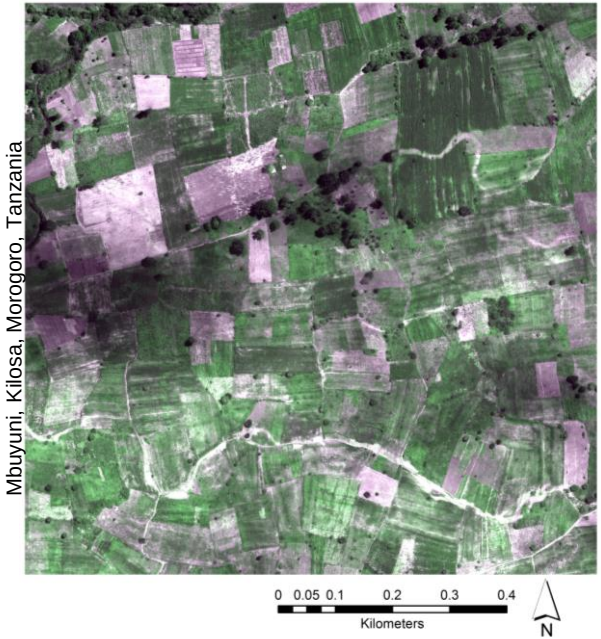

Object Based Image Analysis

- Segmentation
- Spectral Merging
- **Supervised Classification**

Crop Metrics for Management units

- Results used to calibrate and validate space-borne crop metric estimation algorithms.

Challenges

- ❑ Equipment problems
  - ❑ eBee multispectral sensor overheats causing autopilot malfunction in sunny Tanzanian afternoon
  - ❑ Bird hits, it attracts attaks from terretorial birds often (Neusence)
- ❑ Low Endurance
  - ❑ 15 to 30 minutes depending on the wind speeds and camera choice
  - ❑ Needs three flight missions to cover a 1x1km area
- ❑ BRDF
  - ❑ Hotspot and specular reflectance is a serious problem when flying close to noon or in windy conditions
  - ❑ Difficulty creating stable mosaics
- ❑ Clouds
  - ❑ Change in light conditions caused cloud shadows makes creating radiometrically stable Mosaics quite difficult
- ❑ Low internet bandwidth
  - ❑ Difficult to transfer data from Tanzania to UMD

Lessons Learned

- Building capacity for sUAS operation at local institutions in Tanzania was fairly easy
- However good results still need oversight by a remote sensing expert
  - Evaluate intermediate results in the field
  - Fix problems with the UAV operation protocol and schedule
  - Manage data
- COTS systems, however expensive, still need through testing
  - Need for a test site near UMD
- UMD UAS test site

UMD UAS test site

- ❏ Supports every aspect of UAS research
  - ❏ Collaborative approach
  - ❏ Airspace integration (COA)
  - ❏ Airworthiness review
  - ❏ Payload Integration and pilots
- ❏ Range of UAVs already available for use.
  - ❏ Fixed wing systems
    - ❏ Endurance range: upto 5 hours
    - ❏ Payload capacitie: upto 12 lbs
  - ❏ Multi-rotor systems
    - ❏ Endurance range: upto 30 min
    - ❏ Payload capacitie: upto 3 lbs


Thank You!