Making UAVs part of your research toolkit: Some common workflows for vegetation mapping
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Outline for talk

1:00 – 1:07 Introduction to drones and their advantages for vegetation mapping

1:07 – 1:15 Descriptions of issues to be aware of with drone mapping including, regulations, equipment and data analysis

1:15 – 1:20 Q&A
UAV Research
Applications

UAV examples

Crop mapping

Precise agriculture

Post-fire monitoring

Sensitive habitat

Forest recovery

Vineyards

Plant water stress
With all the benefits of satellite sensors, why do we need UAVs?

Satellite imagery might be too coarse.

Imagery might have been flown at the wrong time of day, or on a cloudy day.

Satellite might not carry the sensor of interest.
Advantages of UAVs:

Flexible, focused, & precise data, on demand

Drones can deliver fine spatial resolution data at temporal resolutions defined by the end user.

Costs can be very reasonable.

Flight can be controlled: height, resolution, time of day, repeat schedule.

Camera/platform can be chosen by user.

Products include high resolution imagery, point cloud and DSM.

Engaging, hands-on technology.
Advantages: Spatial resolution

Landsat imagery (30m)
Planet imagery (6m)
eBee imagery (2cm)
Advantages: Mission planning

Programmable flight paths are an advantage over manually piloted UASs: they allow for repeat monitoring because they collect measurements over the same configuration multiple times.
Advantages: Multiple sensors

- RGB
- Multispectral
- Thermal
- Lidar
Spectral reflectance and spectral indices

RGB camera: DJI Zenmuse X3 camera

Multispectral camera: Parrot Sequoia multispectral camera

Reflectance curve of green vegetation

RGB (Visible light) index:
\[ \text{VARI} = \frac{(\text{Green} - \text{Red})}{(\text{Green} + \text{Red} - \text{Blue})} \]

Multispectral indices:
\[ \text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}} \quad \text{NDRE} = \frac{\text{NIR} - \text{RedEdge}}{\text{NIR} + \text{RedEdge}} \]
Advantages: Costs

- DJI Mavic: $900
- DJI Phantom: $1,000
- DJI Inspire: $2,000
- DJI Matrice: $5,000
- SenseFly eBee: $20,000

- $700 RGB
- $3,500 Multispectral
- $9,000 Thermal
- $50,000 Lidar
UAV Advantages: Multiple products

from a collection of overlapping images...

you can get all these products!

Orthomosaic

NDVI or other index

Point Cloud

DTM

DSM

Textured Mesh

Repeatable, through time
Phenotypic characteristics

- plant count
- flower count
- leaf size & architecture
- fruit count & size
- plant size, volume, and structure
- plant size variability
- plant condition (spectral indices)
- plant condition variability
- vegetation fraction & canopy cover
- weed plant cover
- plant pattern (spacing, variability)

Links to Management

- yield & productivity
- monitoring
- Prescriptions (applications, rogueing, amendments)
Kelly et al. in prep

Guan et al. 2019

(a) RGB orthomosaic image (4.3 cm GSD)

(b) Color NDVI distribution map (10.5 cm GSD)

NDVI/NDRE

- Good health
- High moisture
- Poor health
- Low moisture

Reflective light

Visible light

Invisible light

Healthy plant

Stressed plant

Red Edge Change
Issues to be aware of
Flying a UAV. Part 107 license

If you have a small drone that is less than 55 pounds, you can fly for work or business by following the Part 107 guidelines. To fly under Part 107 rules, there are 3 main steps:

Step 1: Learn the Rules

Step 2: Become an FAA-Certified Drone Pilot by Passing the Knowledge Test*

Step 3: Register your Drone with the FAA

https://www.faa.gov/uas/commercial_operators/
UAV challenges: Data sizes & processing time

You can get 50-200 acres per flight; and this can take between 4 and 17 hours to process, based on resolution, computer, etc.

![Graph showing data processing size vs. area mapped](image)

![Bar chart showing flight time vs. processing time](image)
Things can go wrong
Local & cloud platforms for UAV storage, processing and sharing

UAV data volume and detail means pushing the boundary on storage, processing (machine learning tools, cloud tools) and sharing.
Drone Camp

Mission planning
Risk management
Regulatory compliance
Equipment checks
Calibration
Working with apps
Launch sequence
Manual flight skills
In-flight troubleshooting
Data management

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DroneCamp: Continual training for flight skills, safety and regulation
References


Hogan et al.. 2017. Unmanned aerial systems for agriculture and natural resources. California Agriculture 71(1): 5-14
