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

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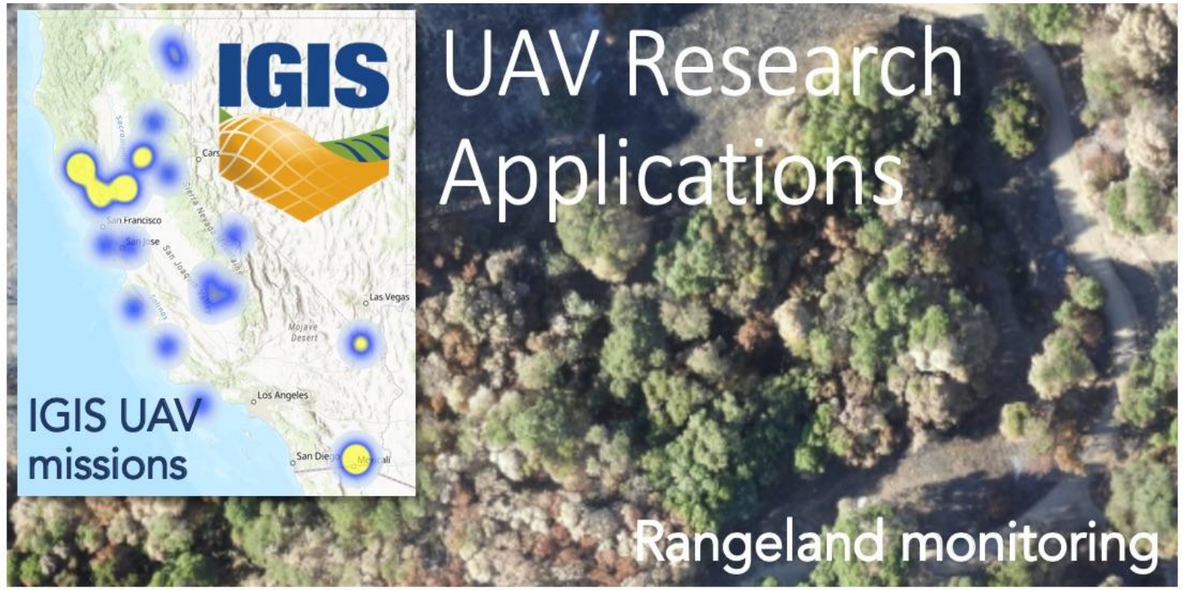
Maggi Kelly, UC Berkeley, UC Agriculture & Natural Resources
Informatics & GIS Program (https://igis.ucanr.edu/)

Outline for talk

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

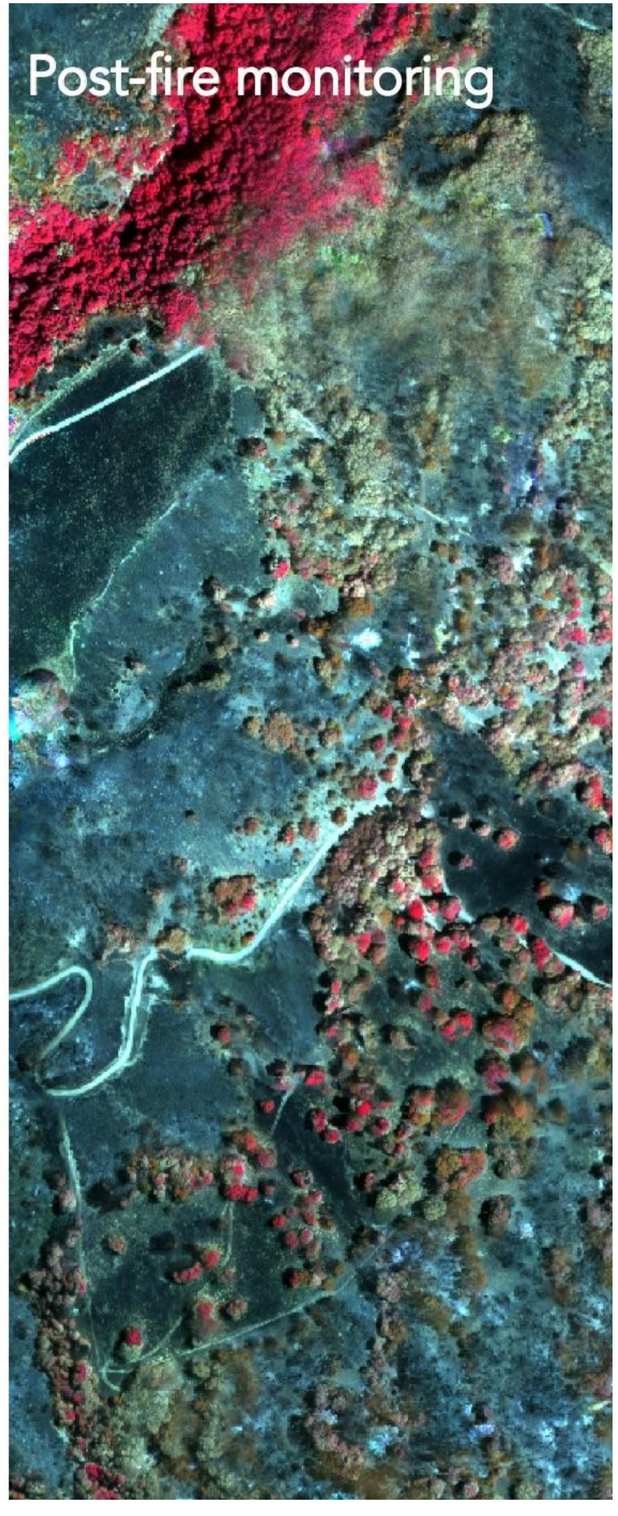
1:07 – 1:15 Descriptions of issues to be aware of with drone mapping including, regulations, equipment and data analysis

1:15 – 1:20 Q&A


IGIS
IGIS UAV missions
UAV Research Applications
Rangeland monitoring


Sensitive habitat


Forest recovery


Post-fire monitoring


UAV examples
Crop mapping


Precision agriculture


Plant water stress

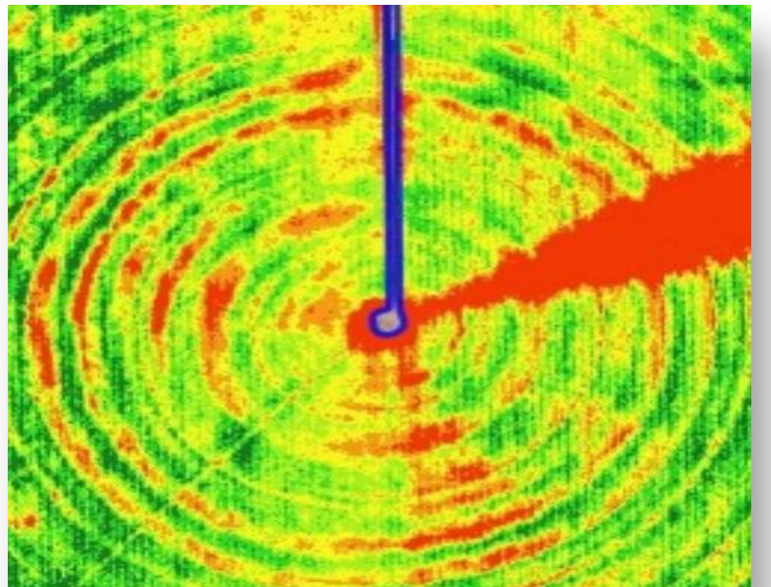

Vineyards

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

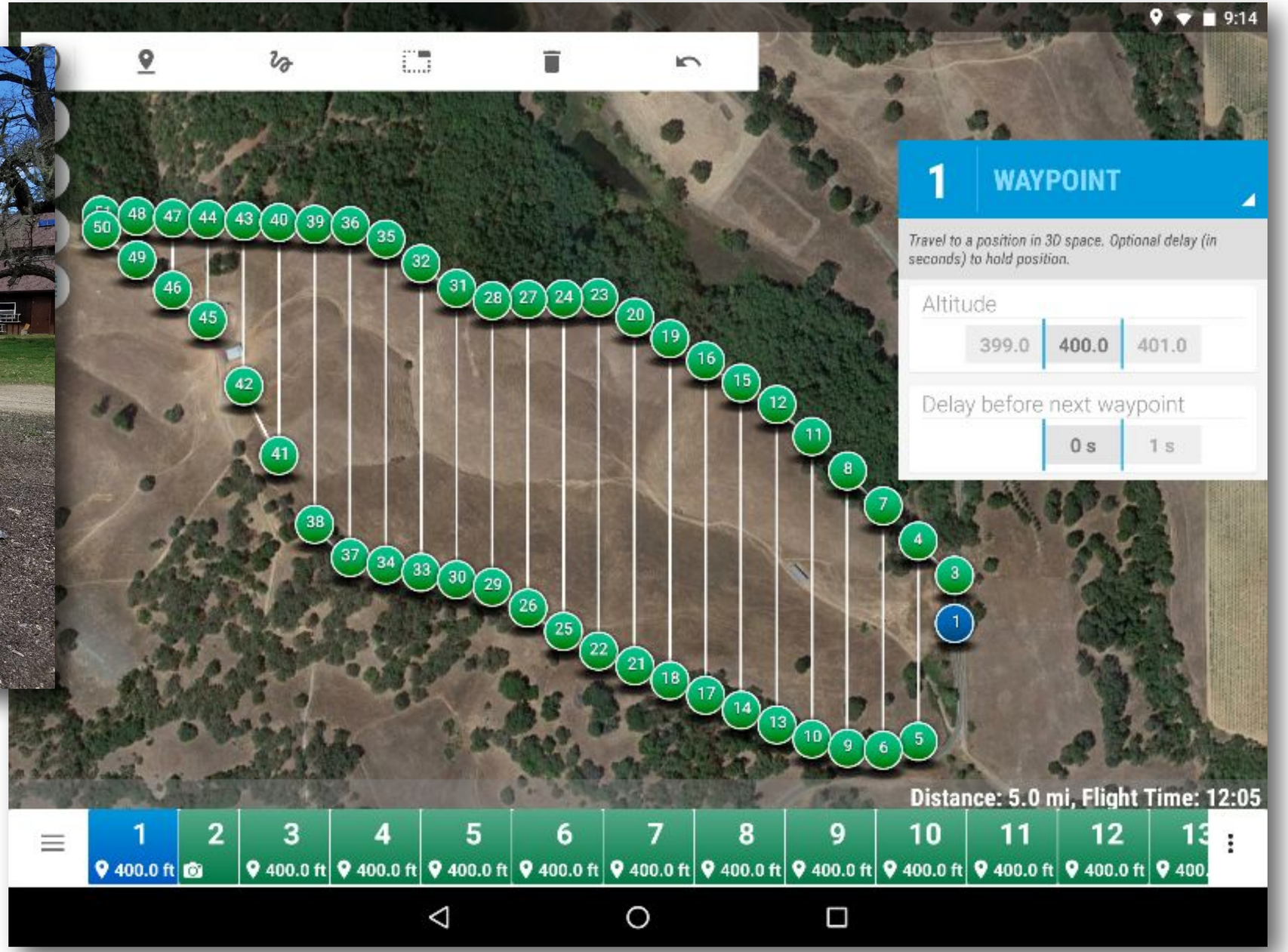
Advantages: Spatial resolution

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

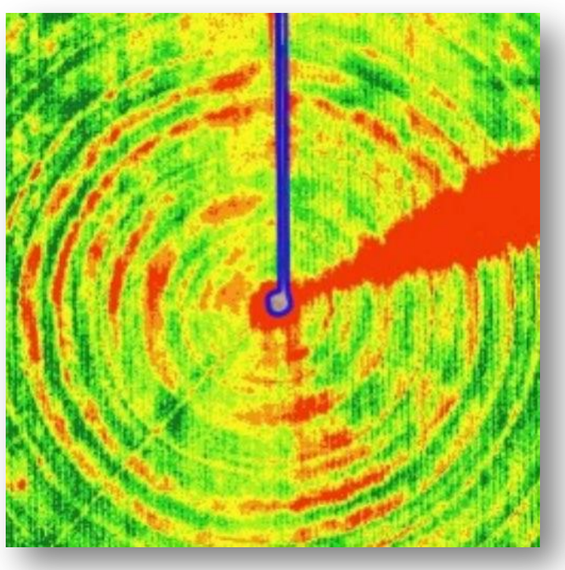
Advantages: Multiple sensors

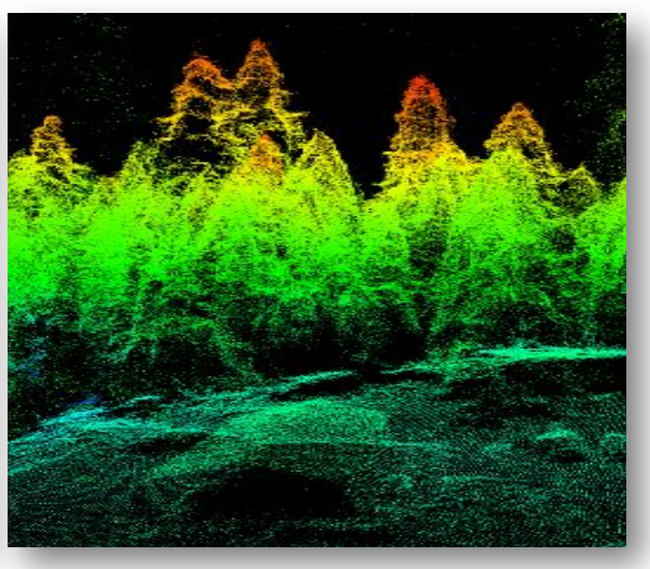
RGB

Multispectral

Thermal

Lidar

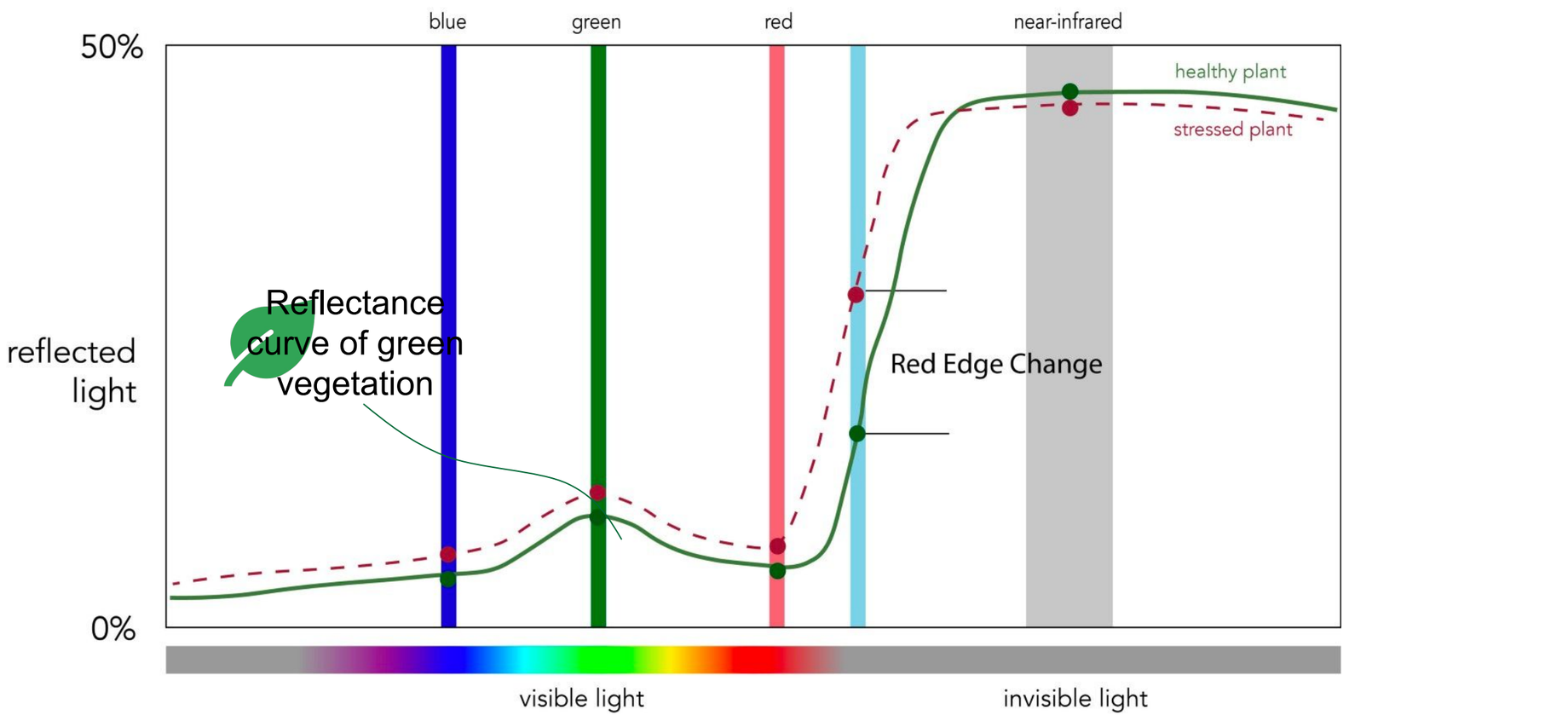




Spectral reflectance and spectral indices

RGB camera:
DJI Zenmuse X3 camera

Multispectral camera:
Parrot Sequoia
multispectral camera



RGB (Visible light) index:

$$VARI = \boldsymbol{(Green - Red) / (Green + Red - Blue)}$$

Multispectral indices:

$$NDVI = \frac{\boldsymbol{NIR - Red}}{\boldsymbol{NIR + Red}} \qquad NDRE = \frac{\boldsymbol{NIR - RedEdge}}{\boldsymbol{NIR + RedEdge}}$$

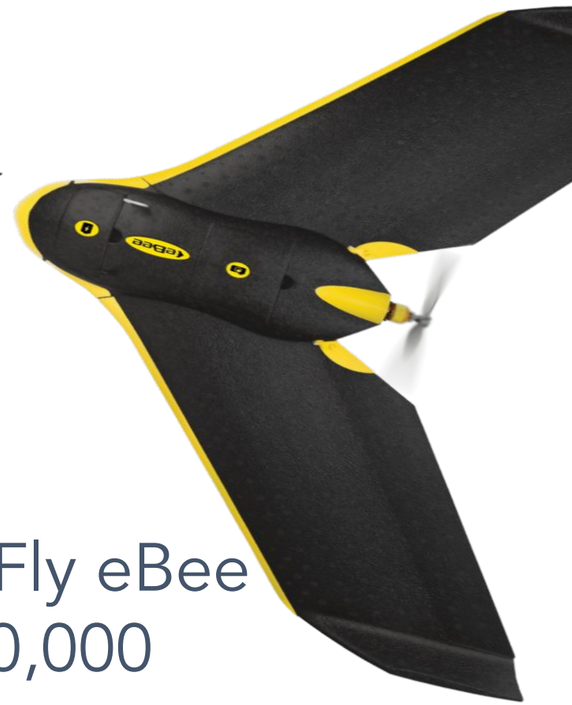
Advantages: Costs

DJI Mavic
$900

DJI Phantom
$1,000

DJI Inspire
$2,000

DJI Matrice
$5,000



SenseFly eBee
$20,000

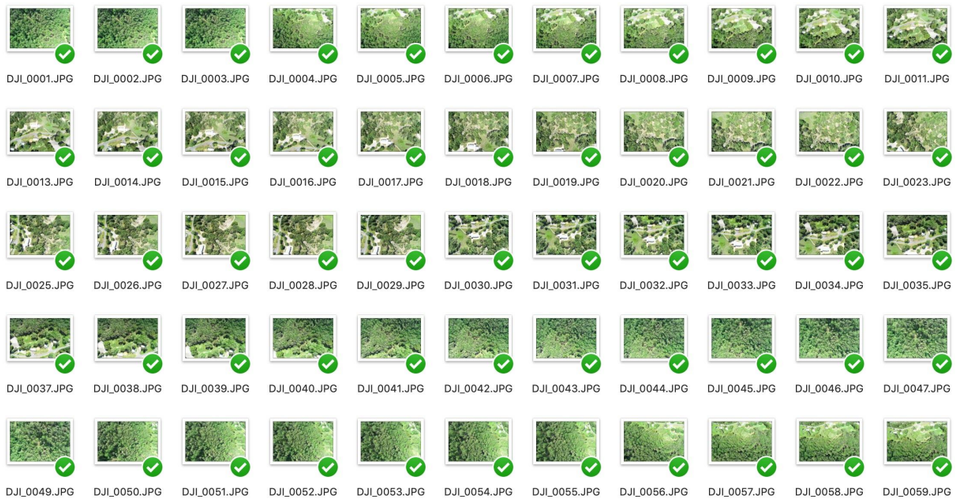
$700
RGB

$3,500
Multispectral

$9,000
Thermal

$50,000
Lidar

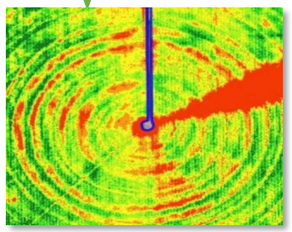
UAV Advantages: Multiple products



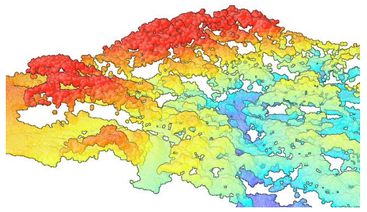
from a collection of overlapping images…

you can get all these products!

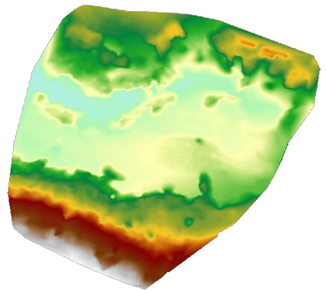
Orthomosaic



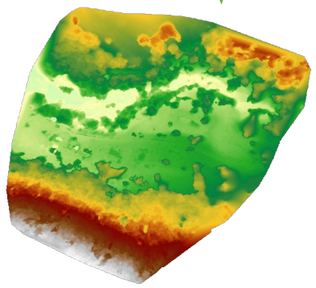
NDVI or other index



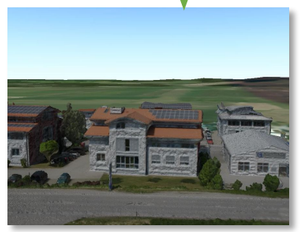
Point Cloud



DTM



DSM

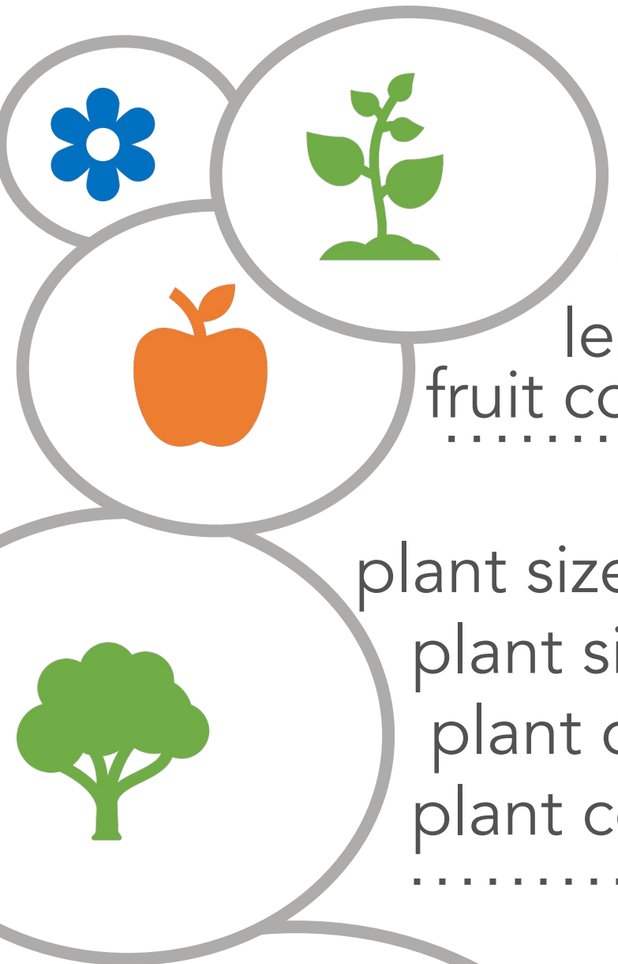


Textured Mesh

Repeatable, through time

Phenotypic characteristics

Links to Management



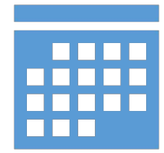
plant count
flower count
leaf size & architecture
fruit count & size

plant size, volume, and structure
plant size variability
plant condition (spectral indices)
plant condition variability

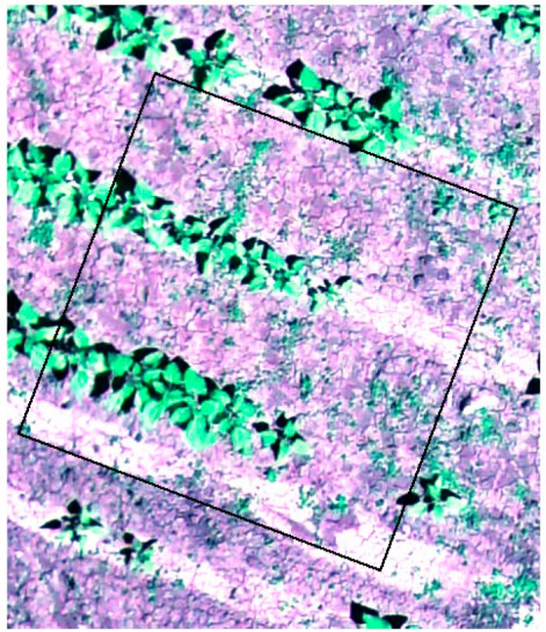
vegetation fraction & canopy cover
weed plant cover
plant pattern (spacing, variability)

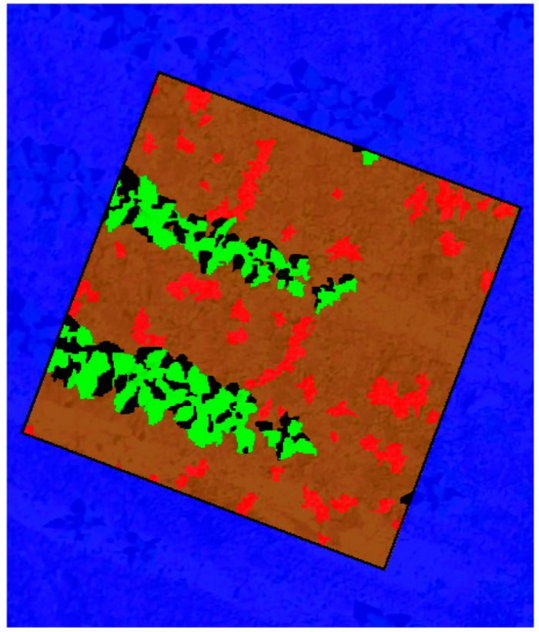
yield & productivity

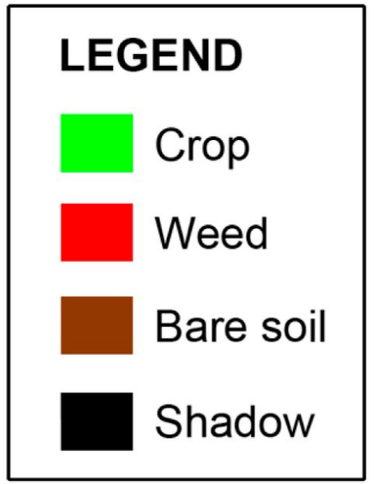
monitoring



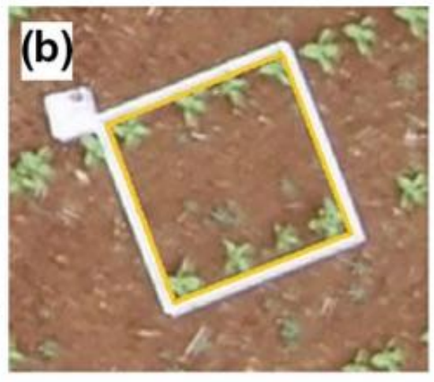
Prescriptions
(applications, rogueing, amendments)

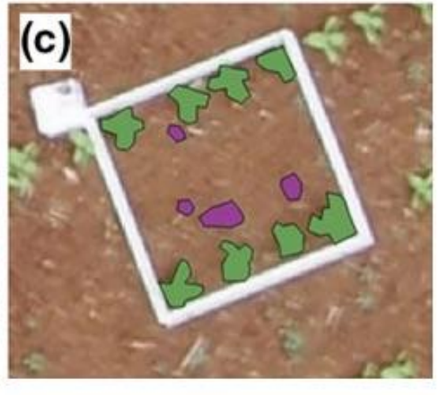


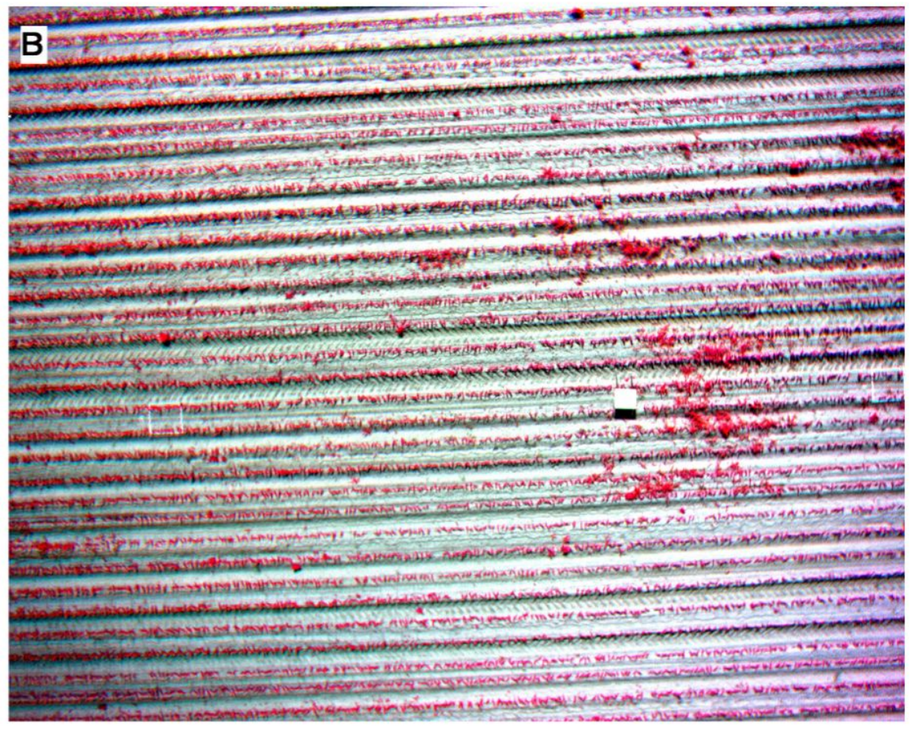




De Castro et al. 2018



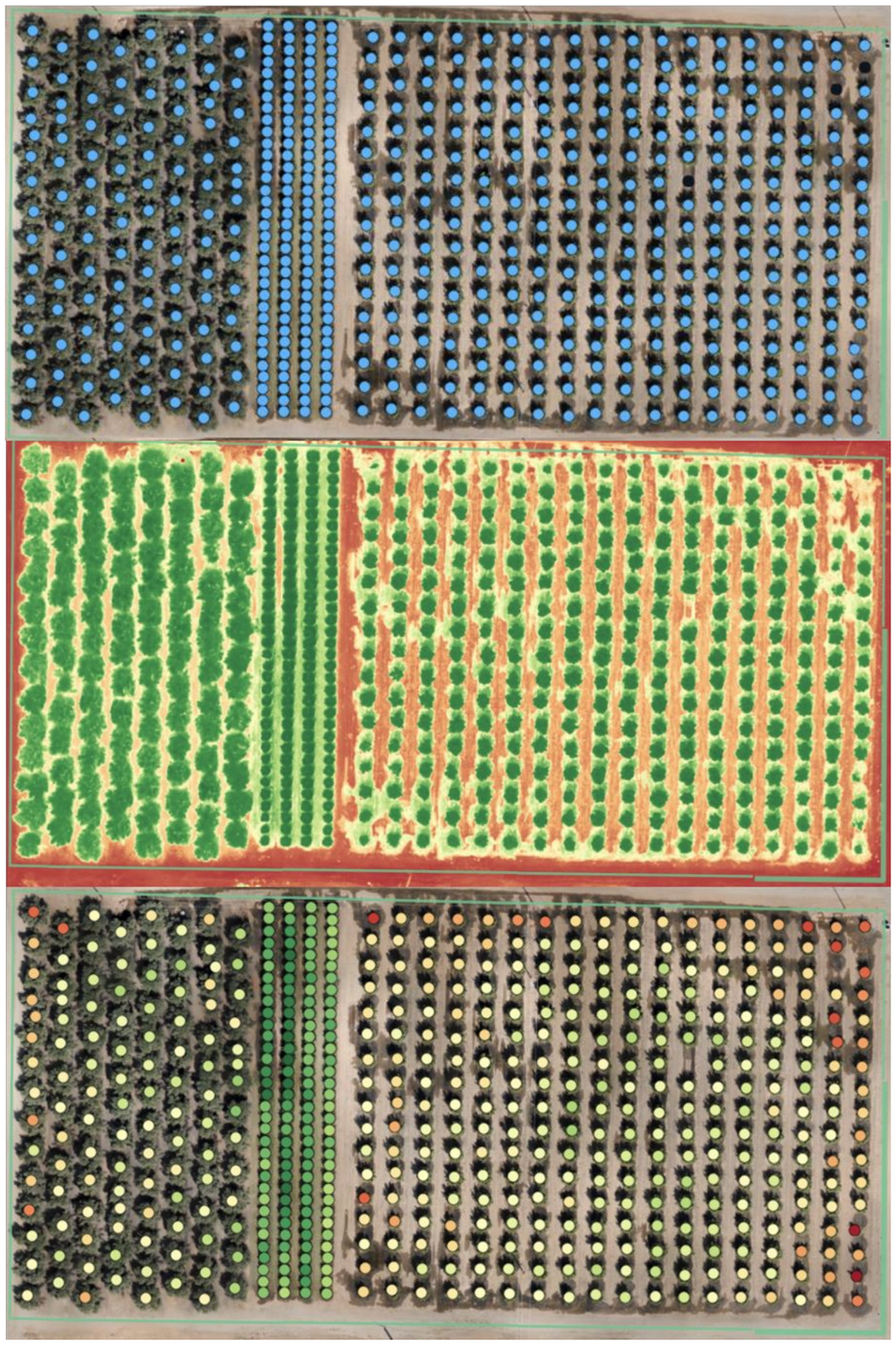


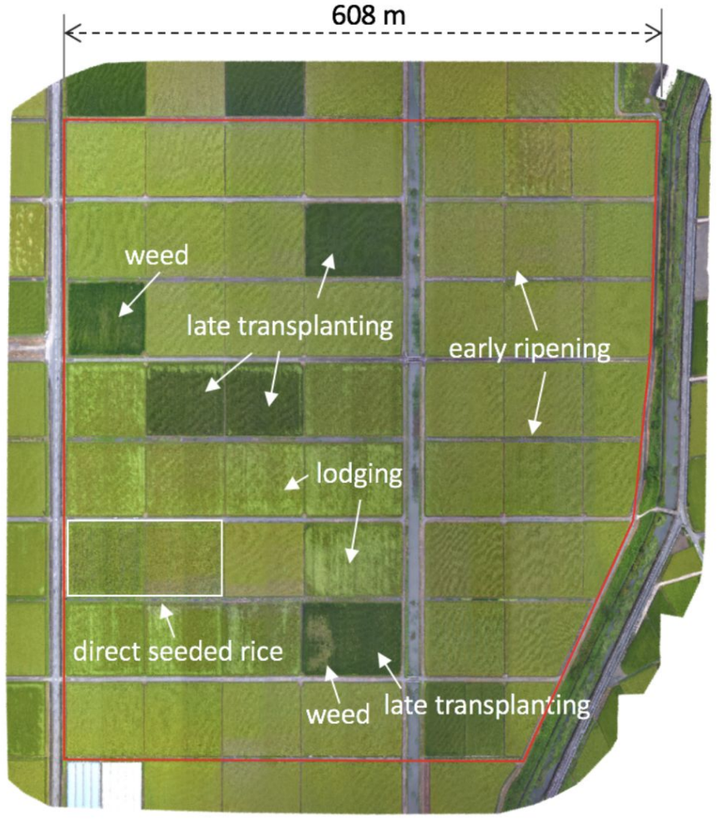


Peña JM, et al. 2013

Lopez-Granados et al. 2016

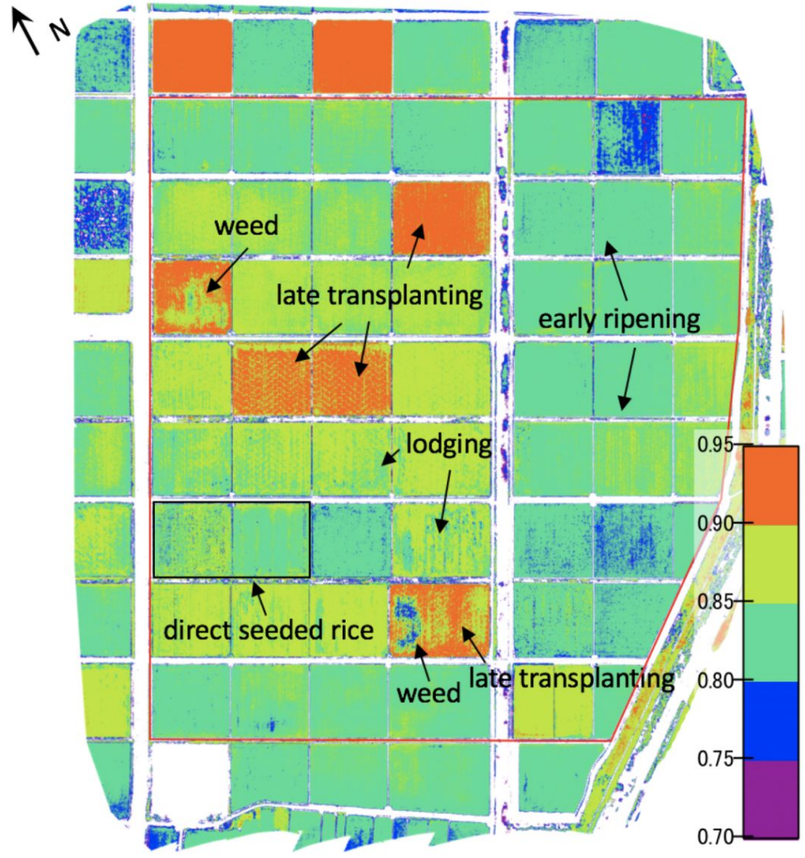
Kelly et al. in prep



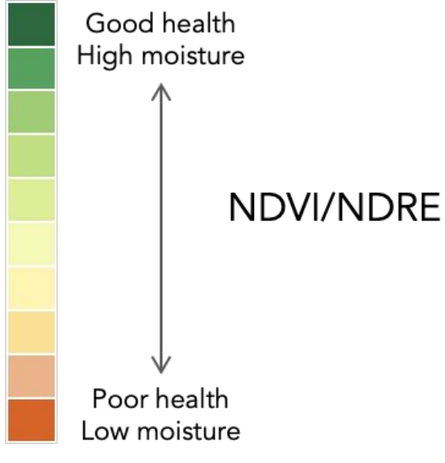


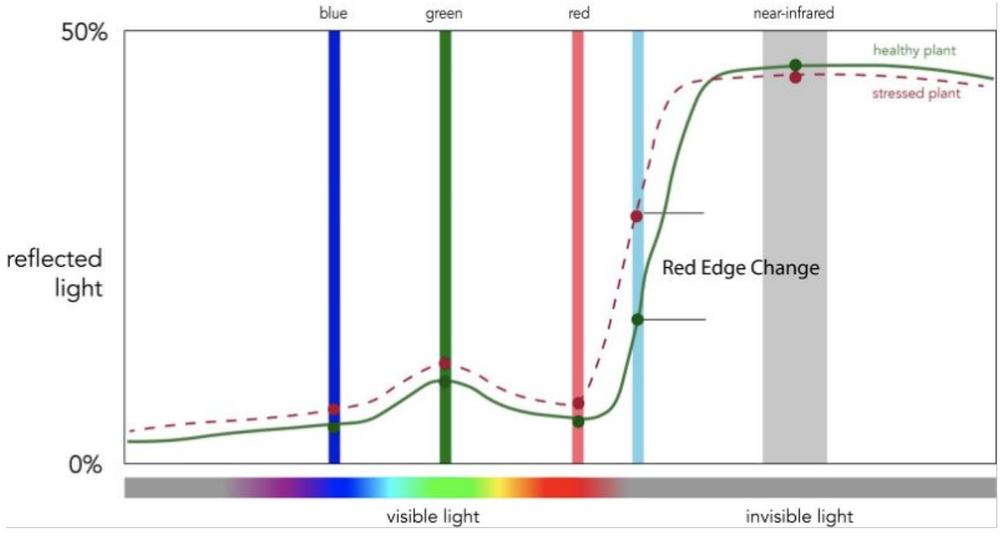
(a) RGB orthomosaic image (4.3 cm GSD)

Guan et al. 2019



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





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/

Top Tasks

Register your drone

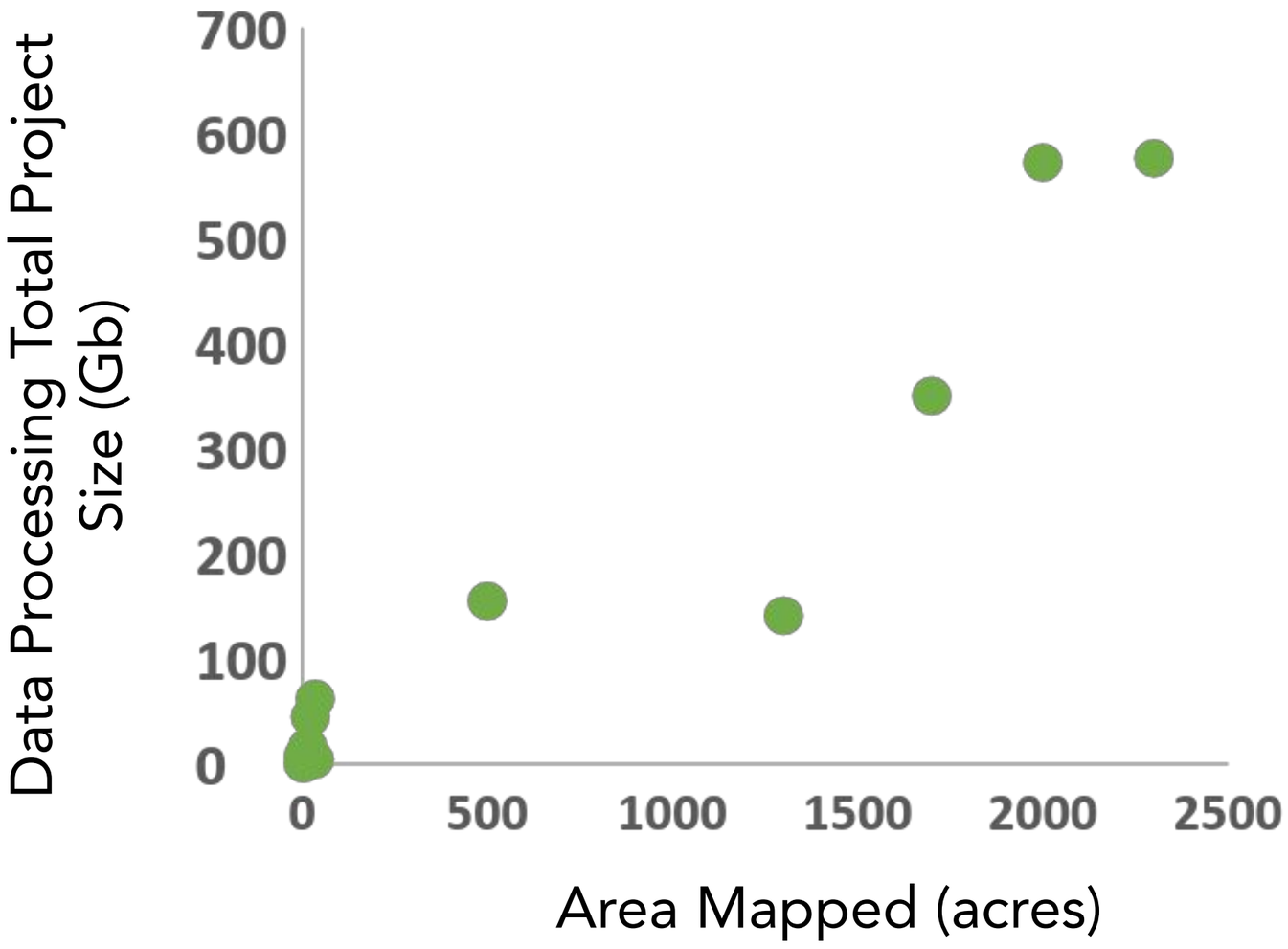
Download the B4UFLY Mobile App

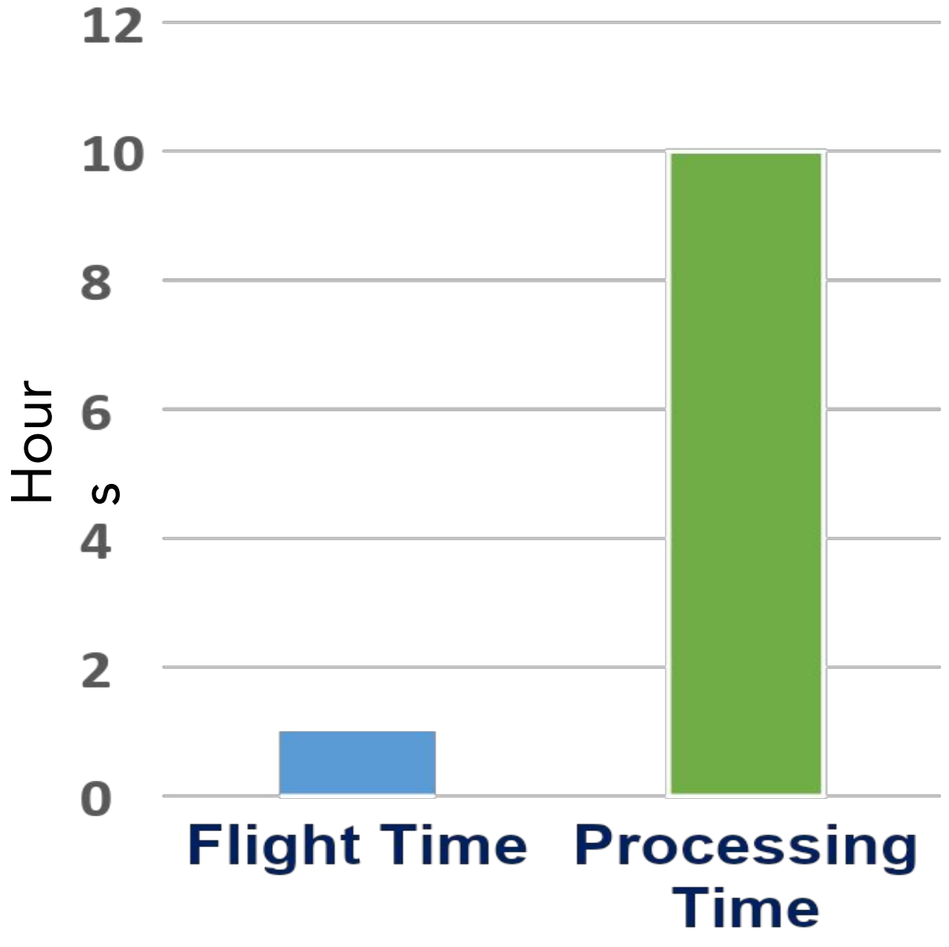
Become a Drone Pilot

Renew Your Remote Pilot's Certificate

Check out Hot Topics in UAS

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.

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.

esri

D2M

PIX4D

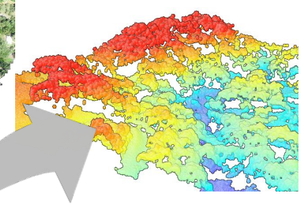
Local

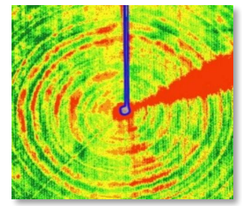
R

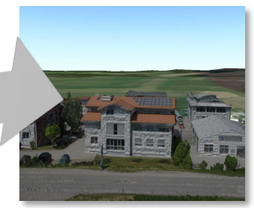
SS

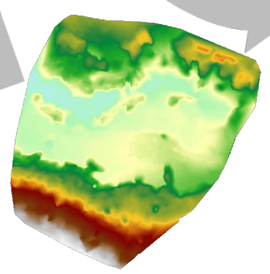
jupyter

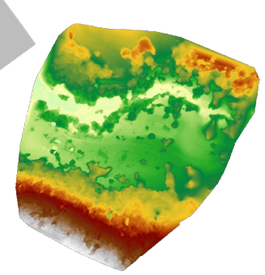
Cloud











DroneCamp: Continual training for flight skills, safety and regulation

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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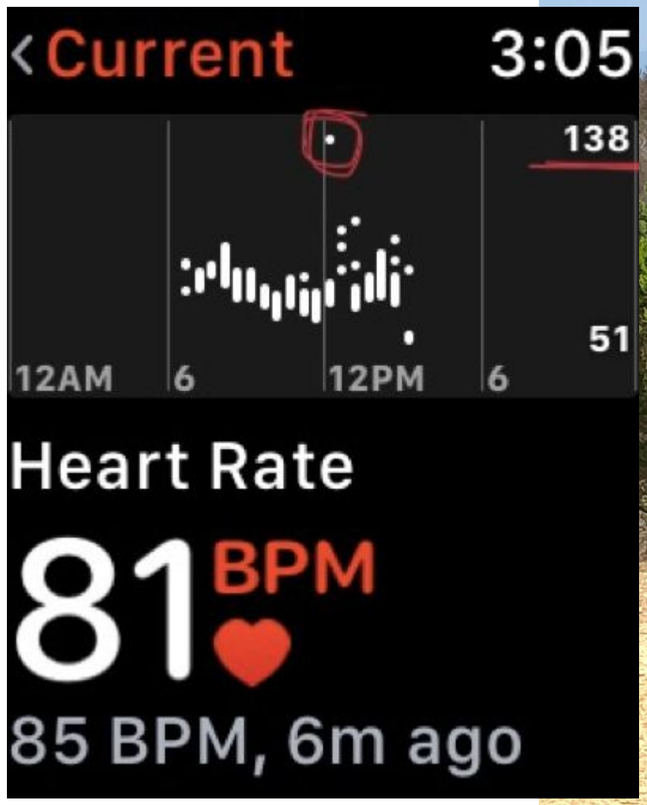

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De Castro et al. 2018. An Automatic Random Forest-OBIA Algorithm for Early Weed Mapping between and within Crop Rows Using UAV Imagery. Remote Sensing. 10(2): 285

Guan et al. 2019. Assessing Correlation of High-Resolution NDVI with Fertilizer Application Level and Yield of Rice and Wheat Crops Using Small UAVs. Remote Sensing. 11(2): 112

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Peña JM, et al. 2013. Weed Mapping in Early-Season Maize Fields Using Object-Based Analysis of Unmanned Aerial Vehicle (UAV) Images. PLoS ONE 8(10): e77151.