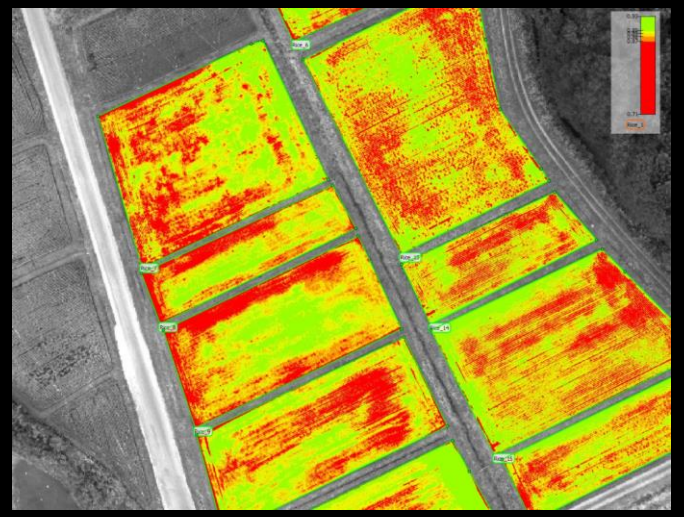
Introducing Drone Flight and Image Processing



Presented by:

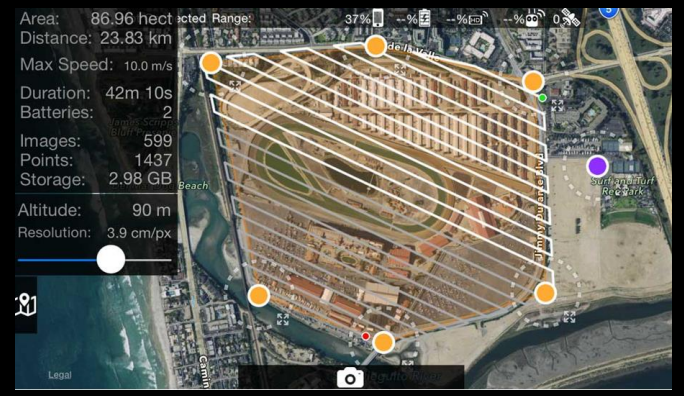
Richard Russell, Drone Services Fiji

Travis Parker, University of California, Davis

Friday, 30 November 2018

Pacific GIS and RS Council Annual Meeting

Suva, Fiji



Workshop overview:

I. (9-9:20) Introduction: How are drones used? Industry directions and trends.

II. (9:20-9:50) Certification and regulations in the Pacific region.

III. (9:50-10:45) Mission planning and demonstration flights.

IV. (10:45-11:00) Imagery processing in Maps Made Easy and Pix4D.

V. (11:00-11:10) Cameras and sensors.

VI. (11:10-12:00) QGIS data processing.

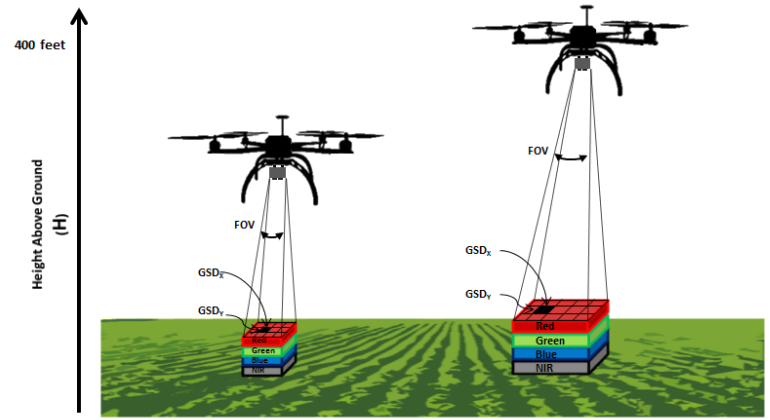
Why UAVs?

UAVs vs. other data collection platforms

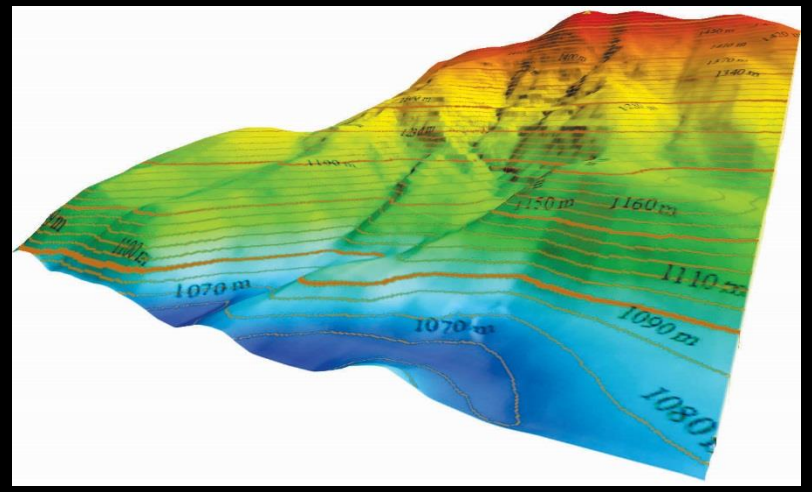
- UAVs offer:
  - High resolution (as good as <0.5cm/pixel)
  - High flexibility
    - Highly portable
    - Only need a brief period of good weather
    - Can be flown in difficult-to-access areas
    - Many different kinds of sensors
  - Fairly low cost

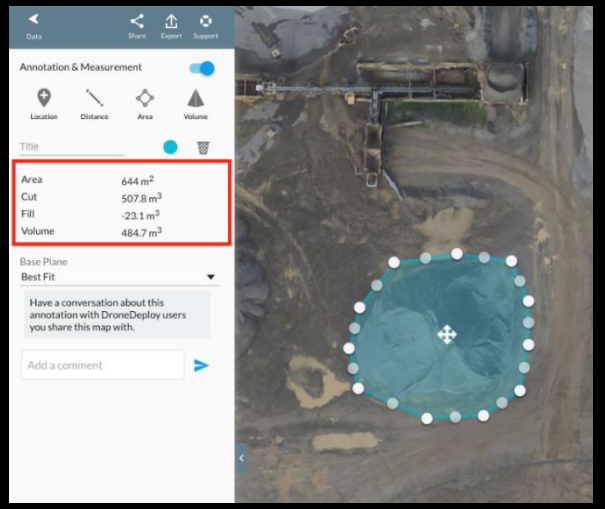
UAV limitations

- Tradeoffs between mapped area and resolution:
  - Flying higher = more area, lower resolution
- Like all systems, there are weather limitations
  - Overcast=no problem
  - Recent rain=no problem
  - Partly cloudy=not ideal for any aerial system
  - But consider the flexibility of UAVs
- Costs for more advanced sensors and processing
  - This is true of other systems as well



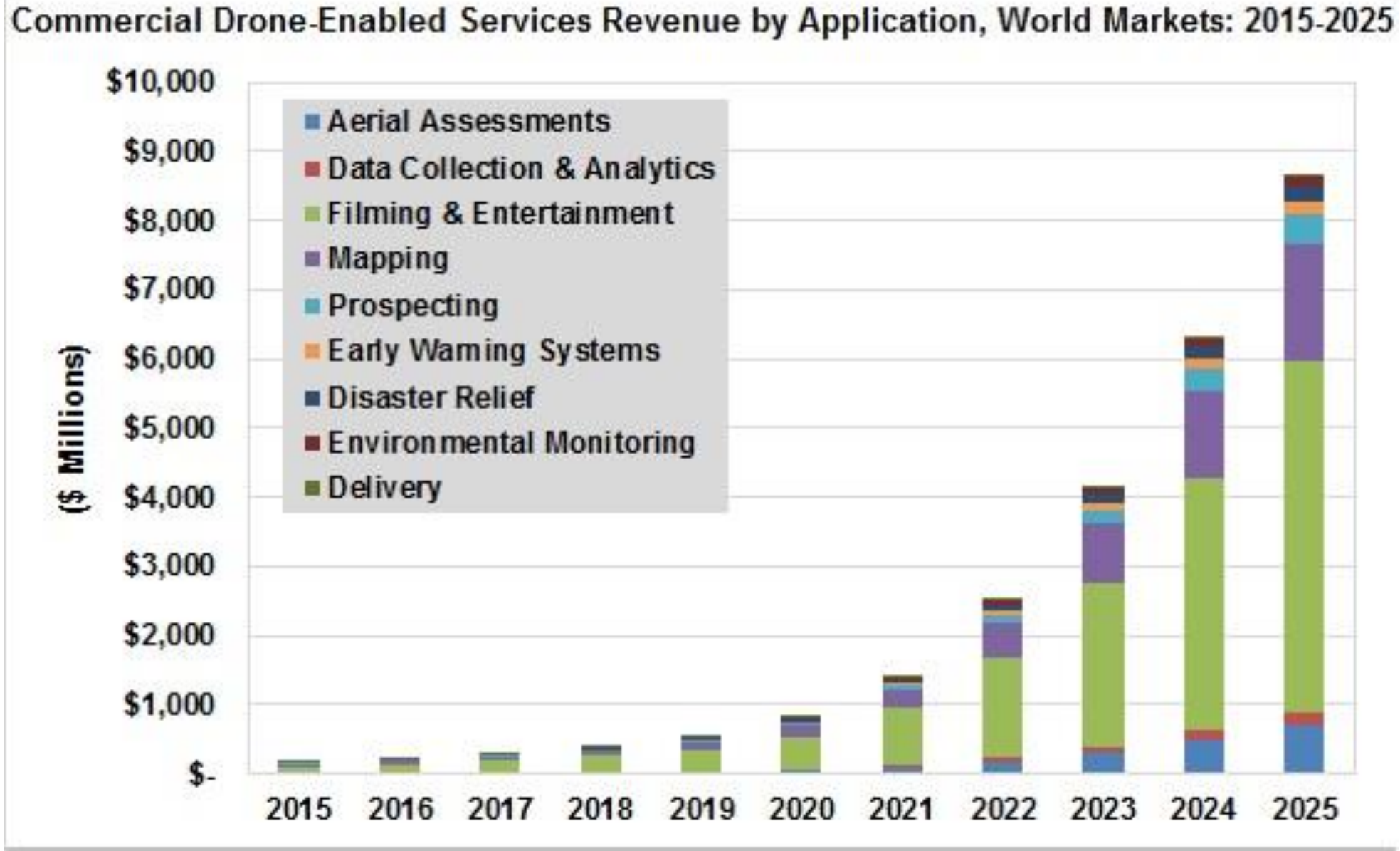
What are the main uses for UAVs?



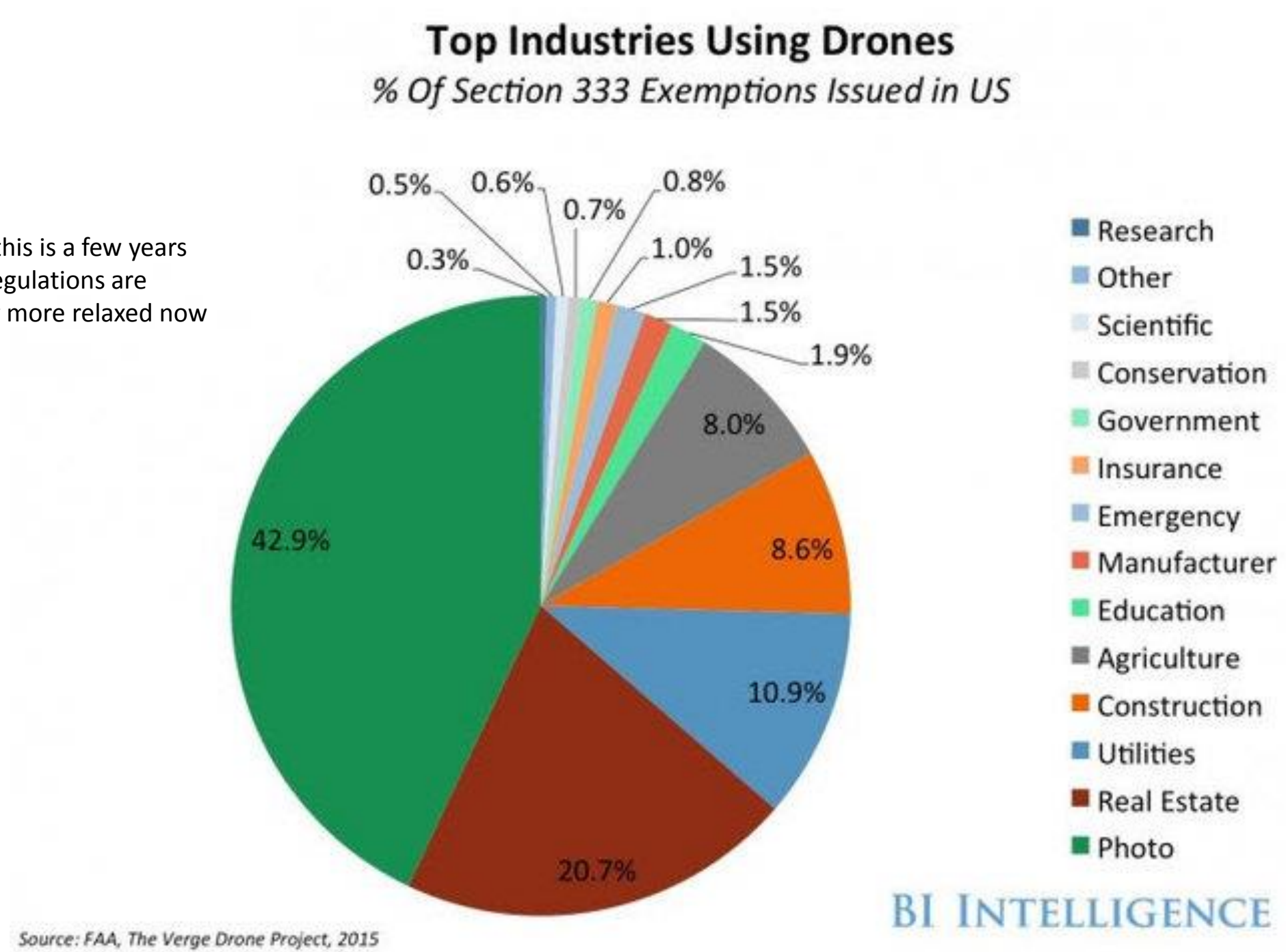


Tractica

Huge growth projections!

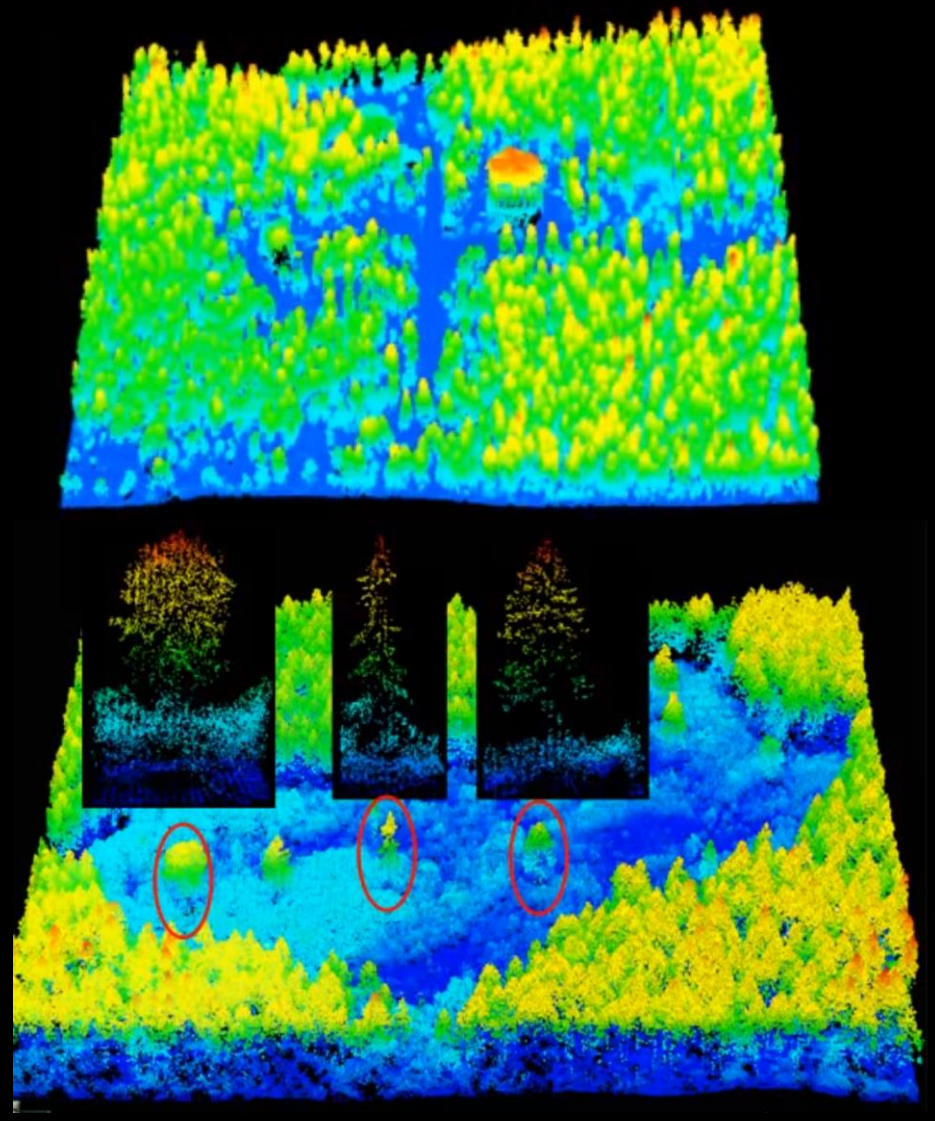


Note that this is a few years old… regulations are considerably more relaxed now



What are the main uses for UAVs?

- Videography
- Industrial
- Real estate
- Law enforcement
- Forestry
- Others (Delivery, military, etc.)



Do you need an expensive sUAS to get quality images and data?

No!

It’s all about the kind of camera. For many applications, true color (RGB) cameras are all that is needed

Several companies have excellent aircraft with RGB cameras

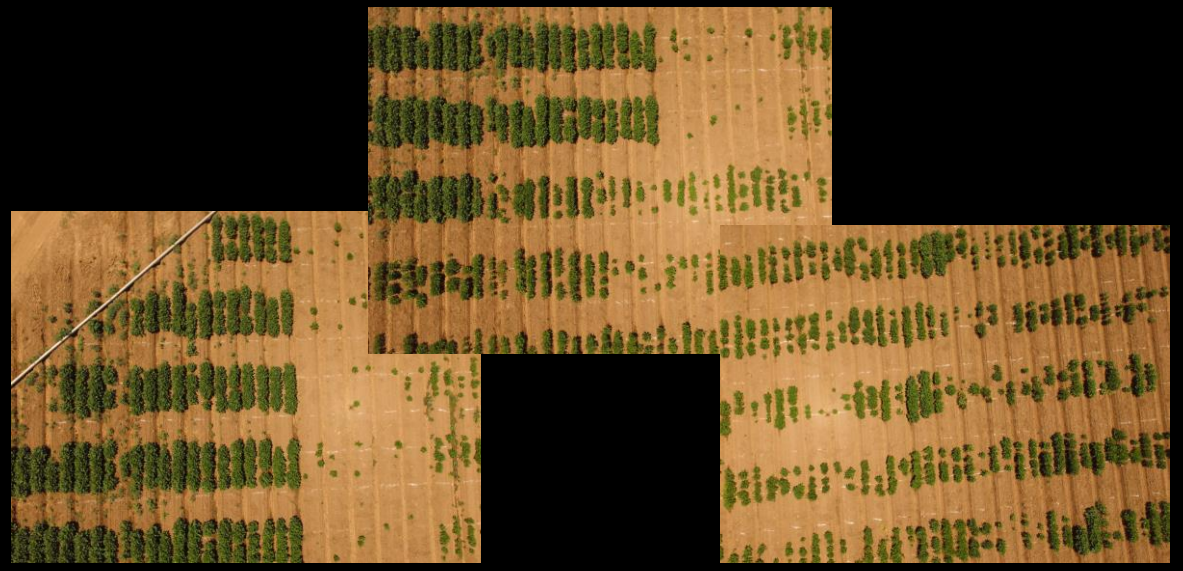
Typical UAS workflow for mapping:

1. Develop flight plan

Typical UAS workflow for mapping:

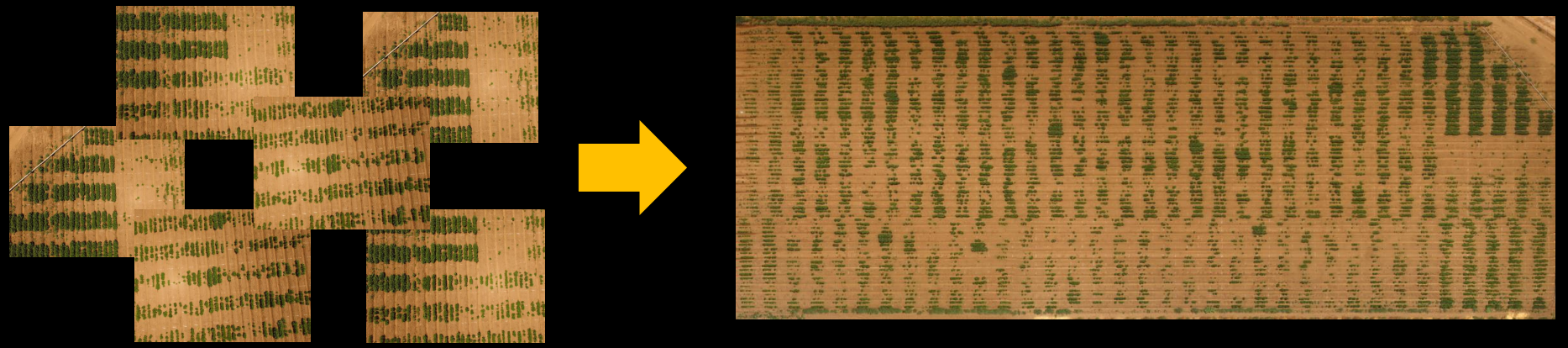
3. Collect data

4. Transfer imagery



Typical UAS workflow for mapping:

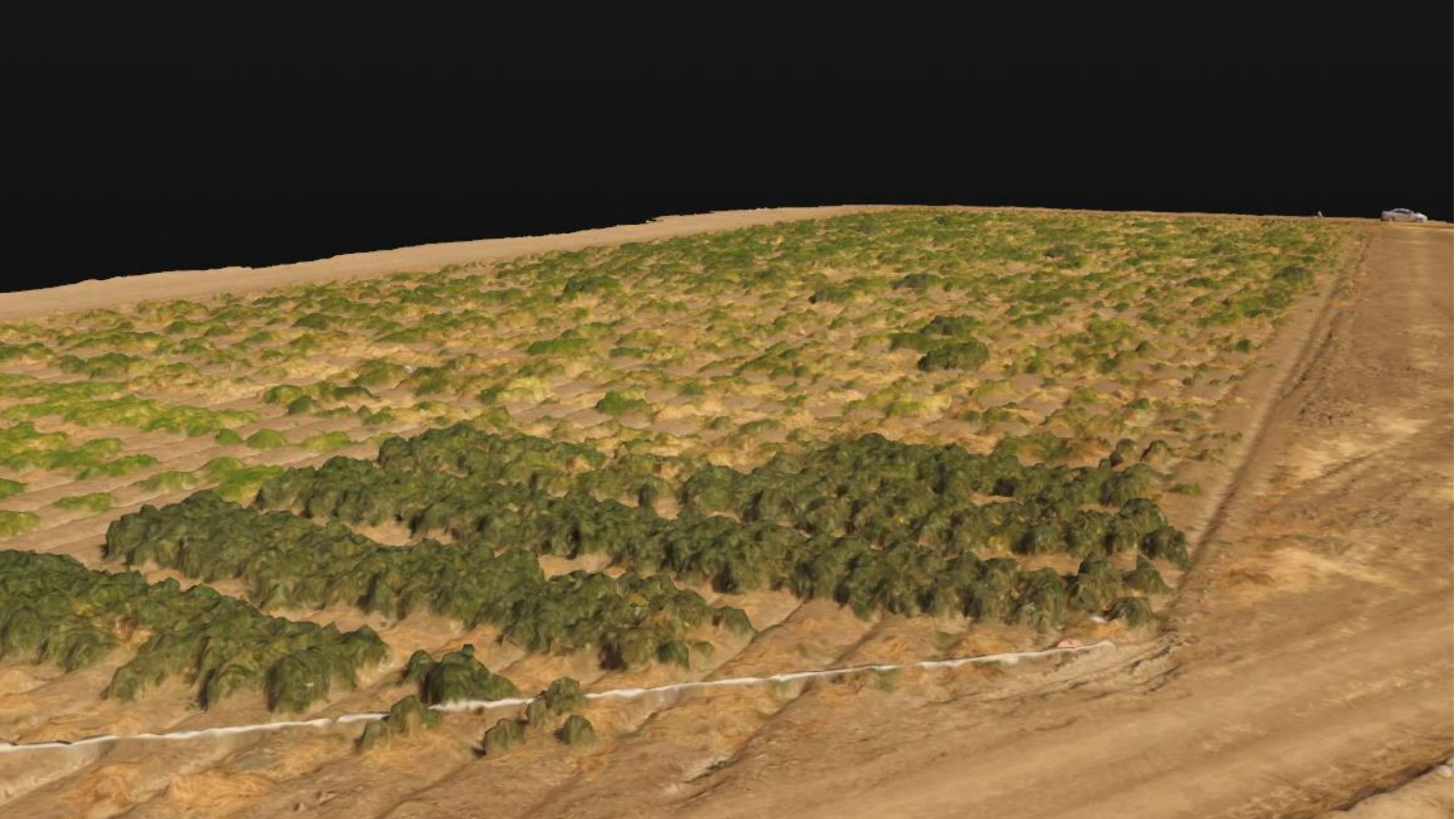
5. Construct models



MAPS MADE EASY

PIX4D

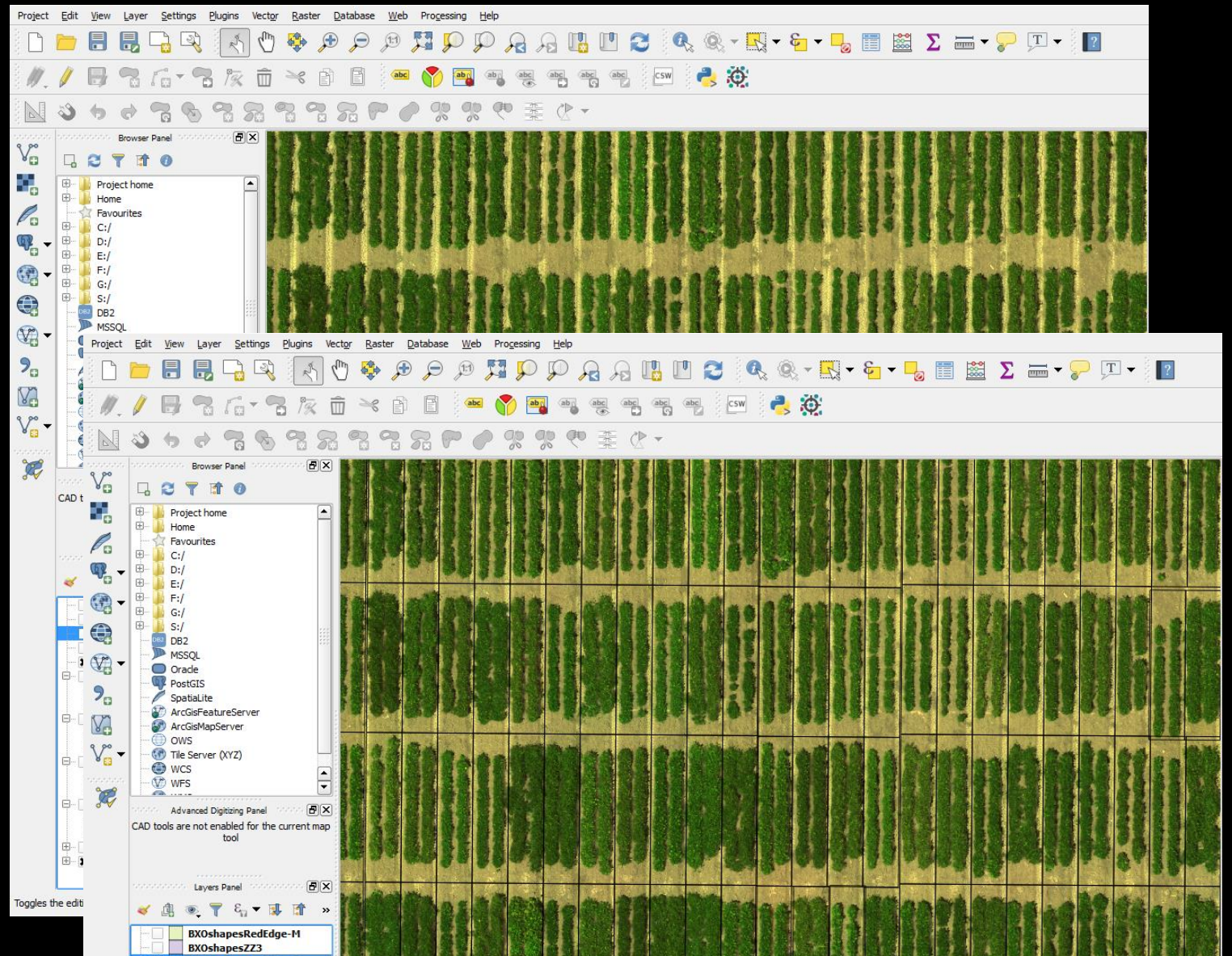
DroneDeploy



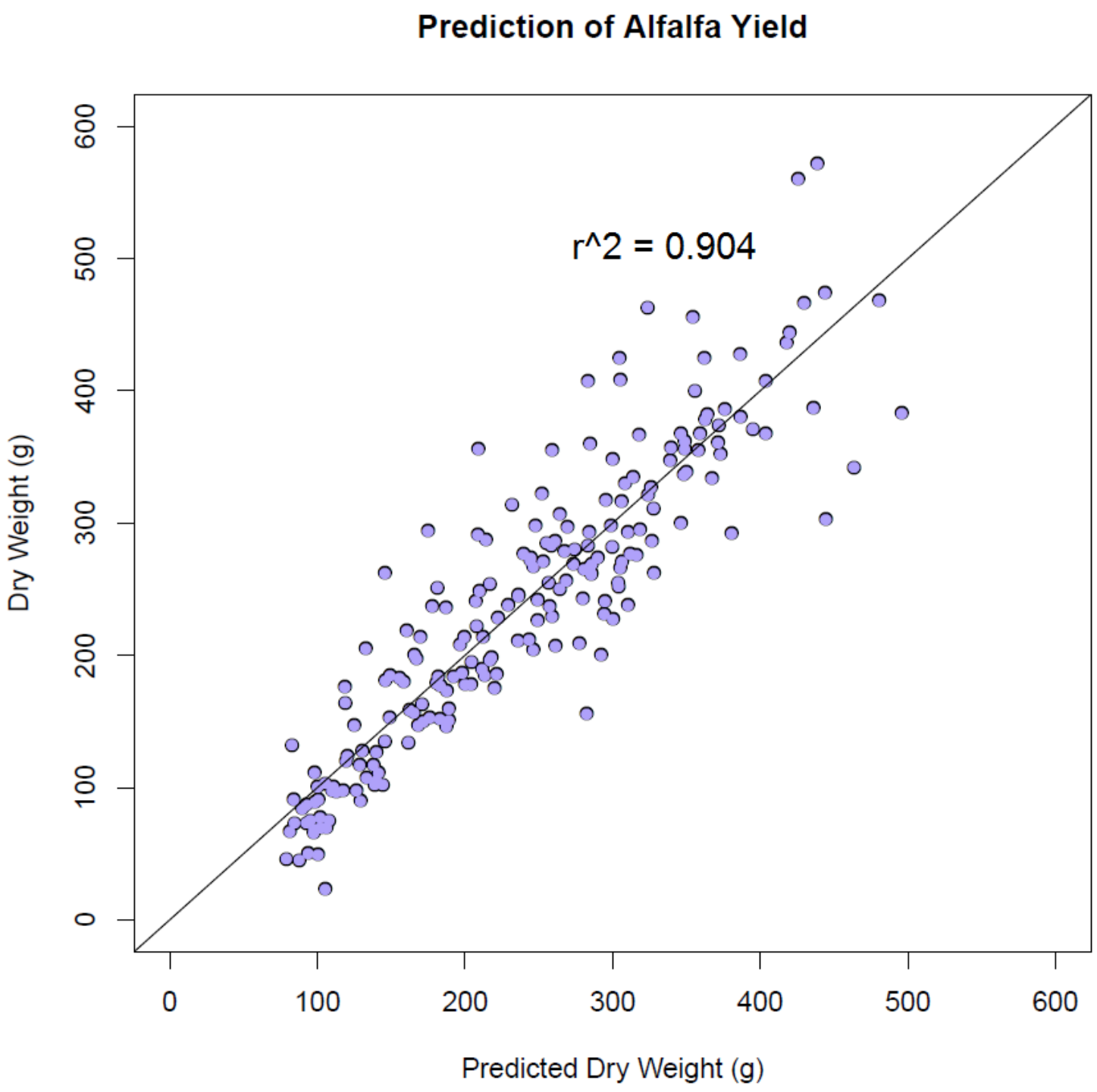
Typical UAS workflow for mapping:

6. Export to other programs (e.g. QGIS)

7. Add shapefiles



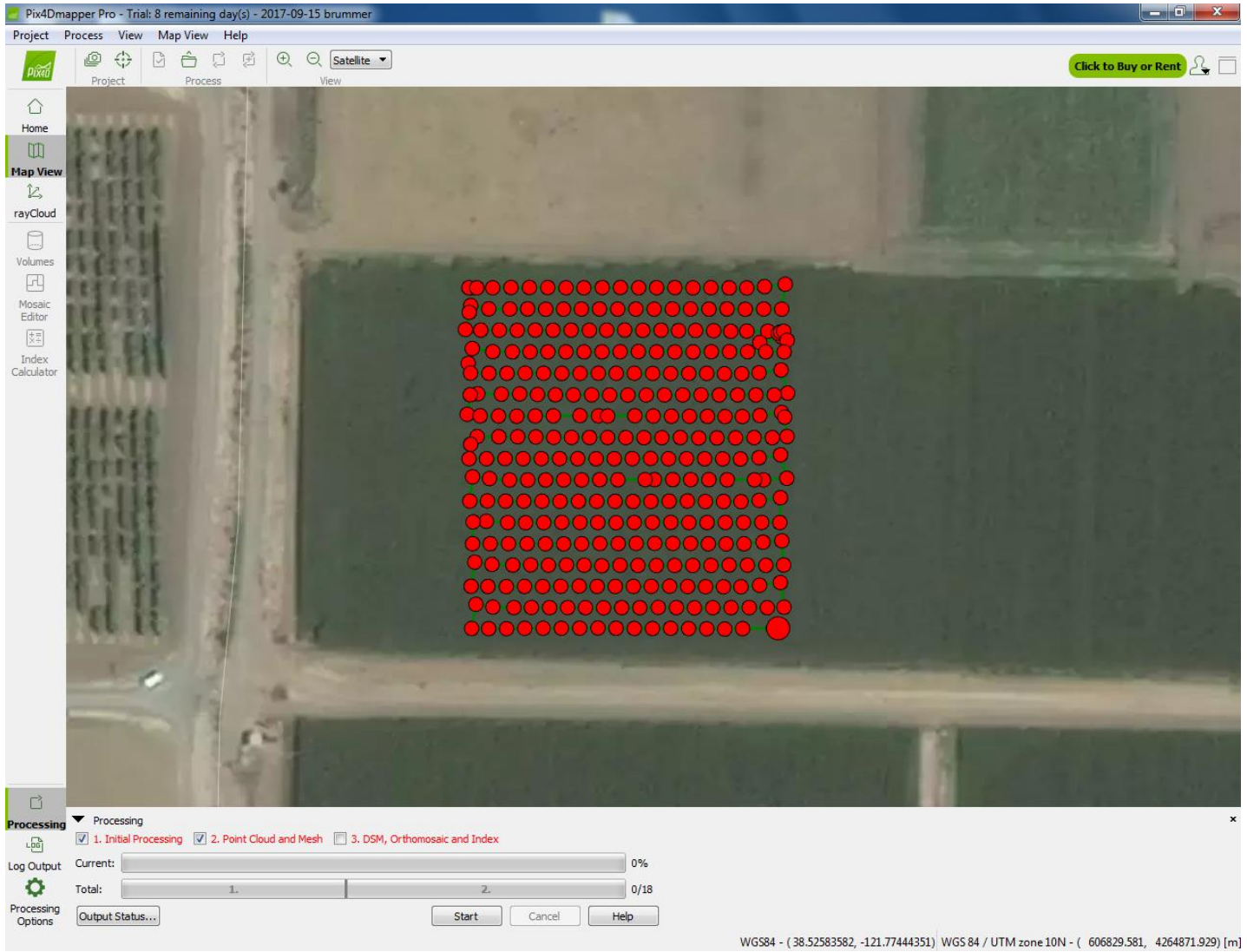
8. Generate and export results



Part II. Drone certification and regulations in the Pacific

Part III. Mission planning

- Using a mission planning app facilitates uniform image spacing



Mission planning

- Several options are available, consider which is best for your needs

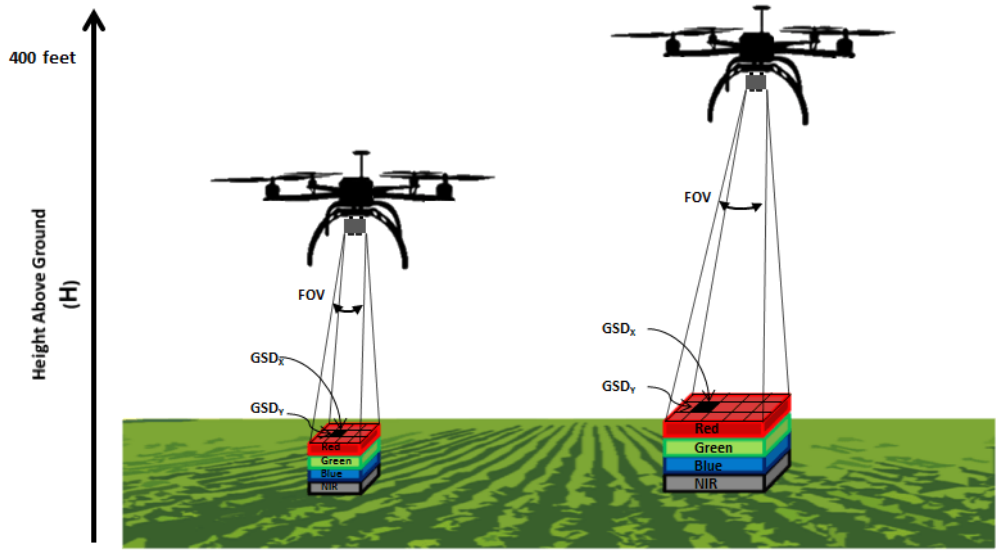
Mission planning

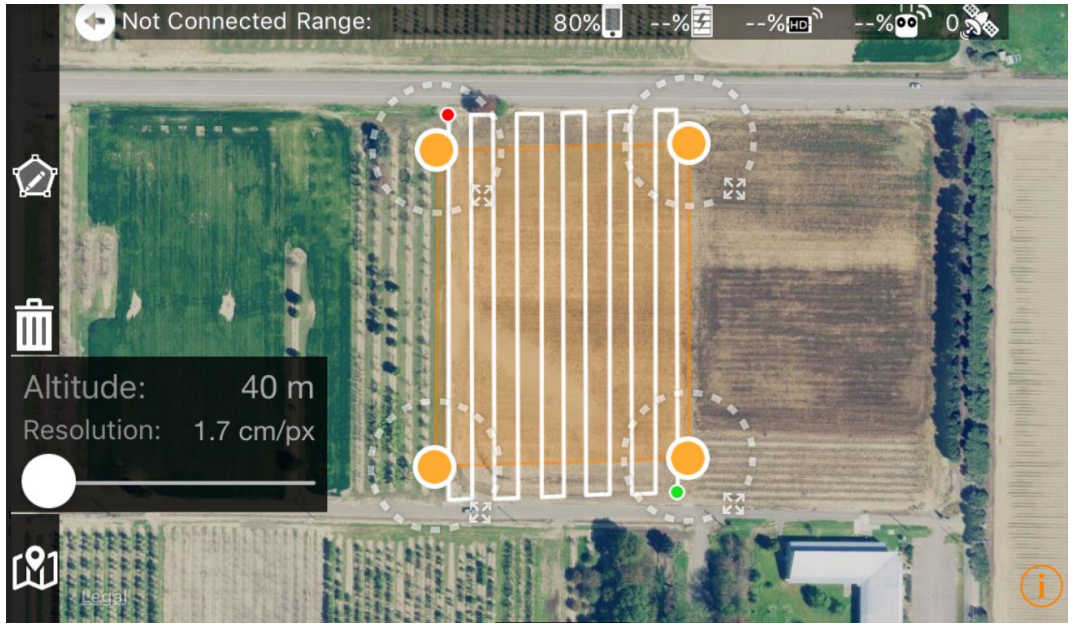
- Considerations before choosing an app
  - Compatibility with device, UAS, cameras
  - Mission resume, repeatability
  - Flexibility vs. ease of use
  - Probability of error

- Most are free or inexpensive, try several

Mission planning

- Trade-offs
  - Higher altitude=more area/time, but lower resolution.



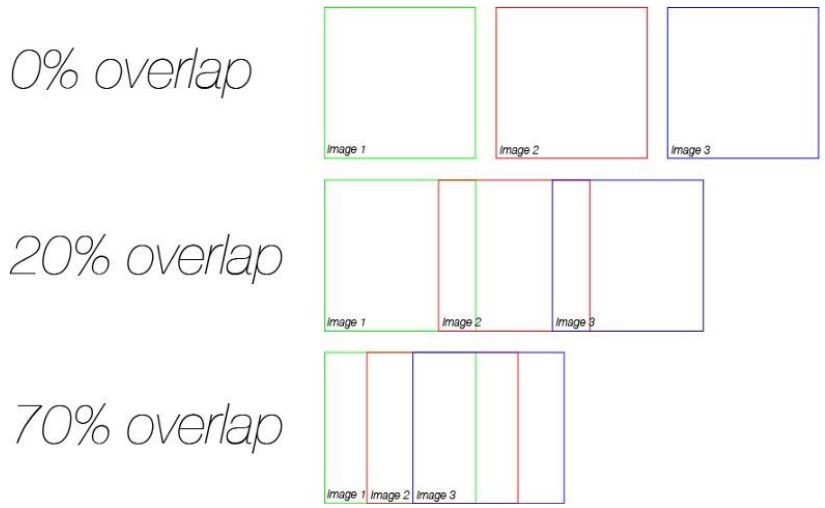


Altitude: 40m; Overlap: 75/85; Time: 9m 21s

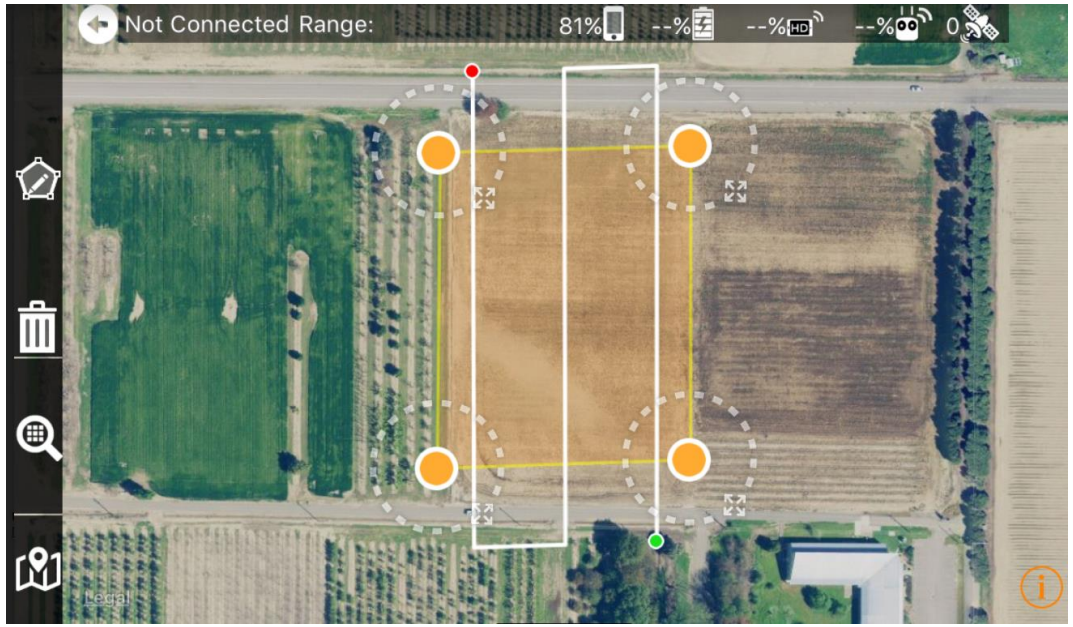
Altitude: 80m; Overlap: 75/85; Time: 4m 12s

Mission planning

- Trade-offs
  - Higher overlap increases stitching quality, but reduces area/time
  - Ideal overlap depends on mapped surface



Altitude: 80m; Overlap: 75/85; Time: 4m 12s

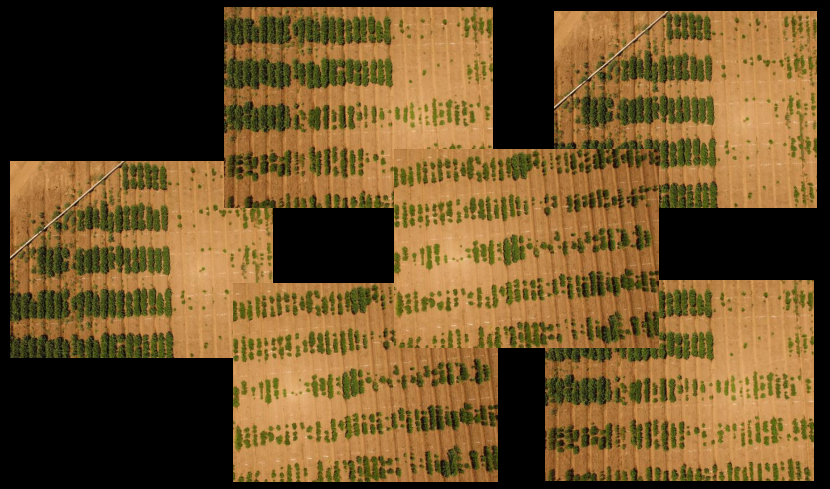


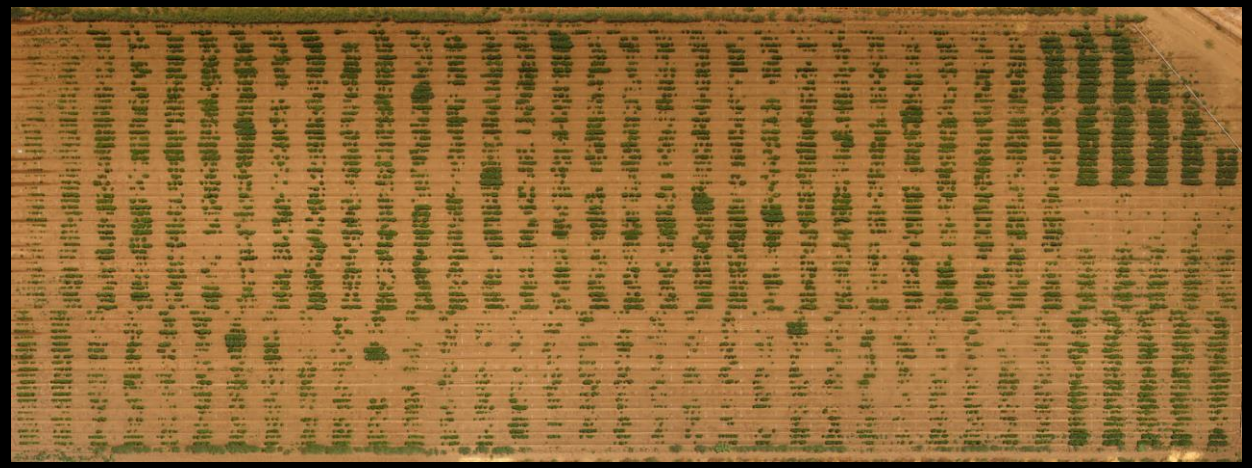
Altitude: 80m; Overlap: 70/70; Time: 3m 11s

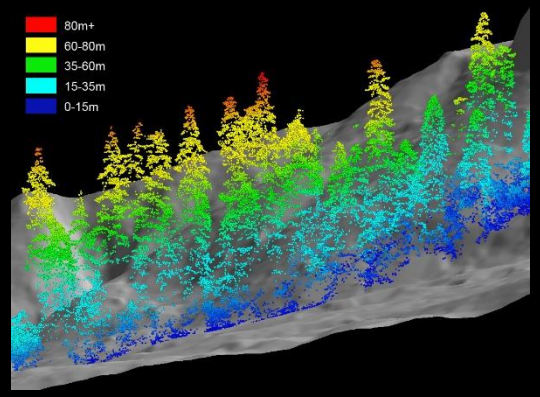
Let’s fly!

- Agriculture will need major advances in coming decades
- Drones are useful for many different agricultural applications
- Drones collect highly precise, high-throughput data, which was out of reach just a few years ago
- Drones are an excellent outreach tool for engaging the public and the next generation of innovators

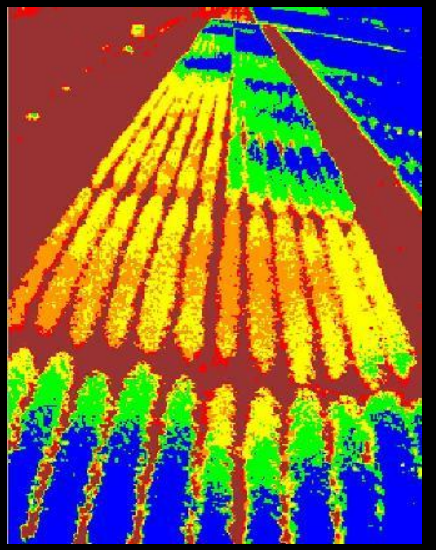
Part IV. Orthomosaic and model generation

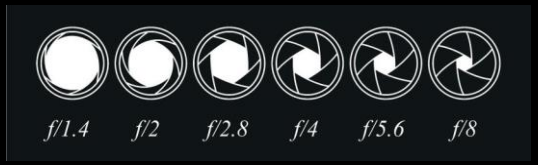


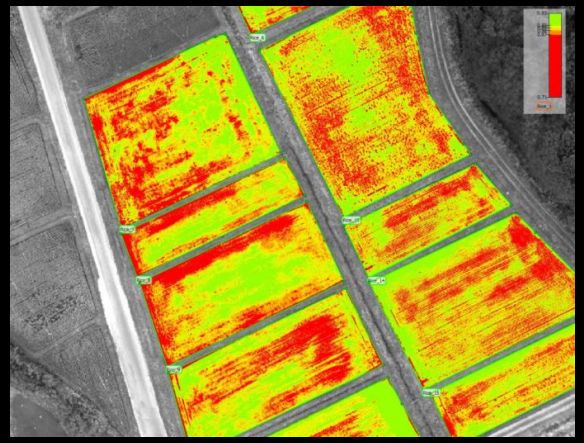


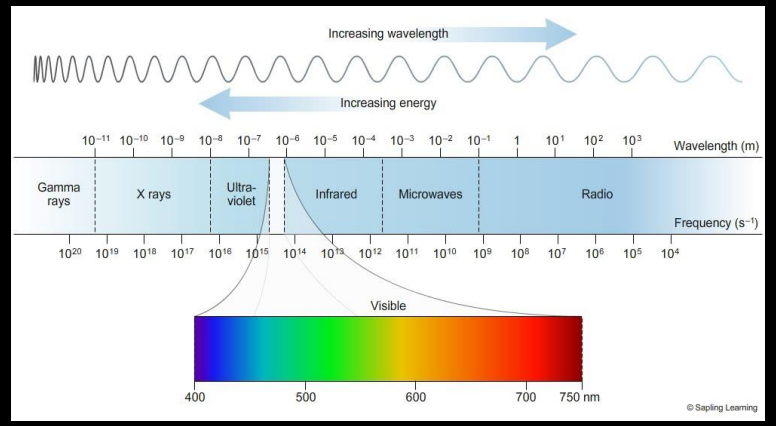


Part V. Sensors, cameras, and vegetation indices



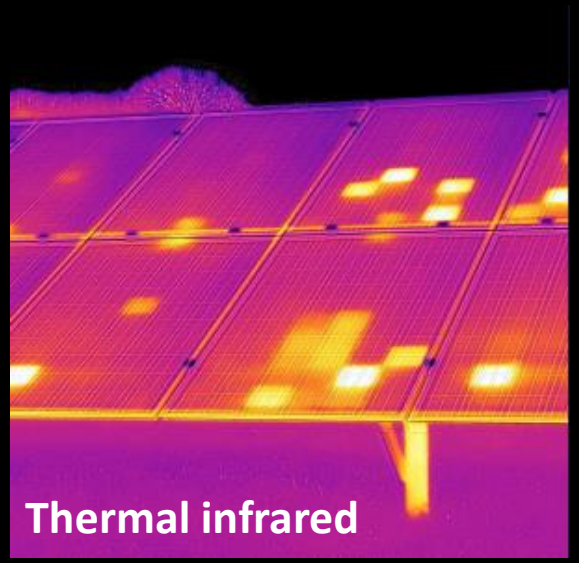


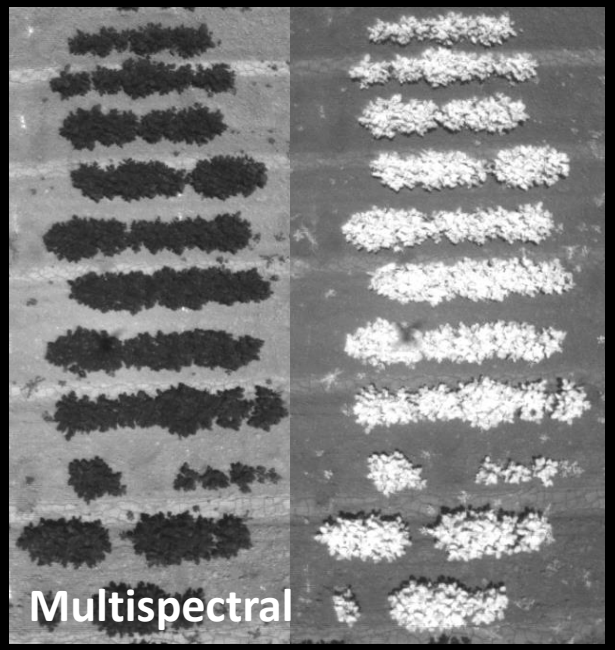


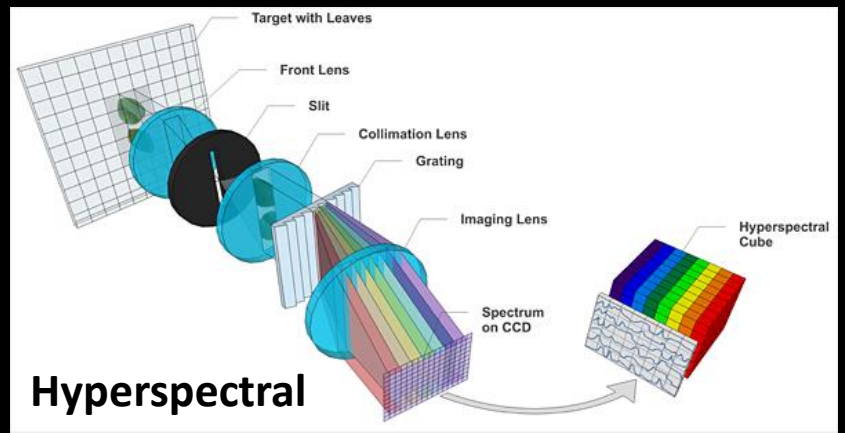


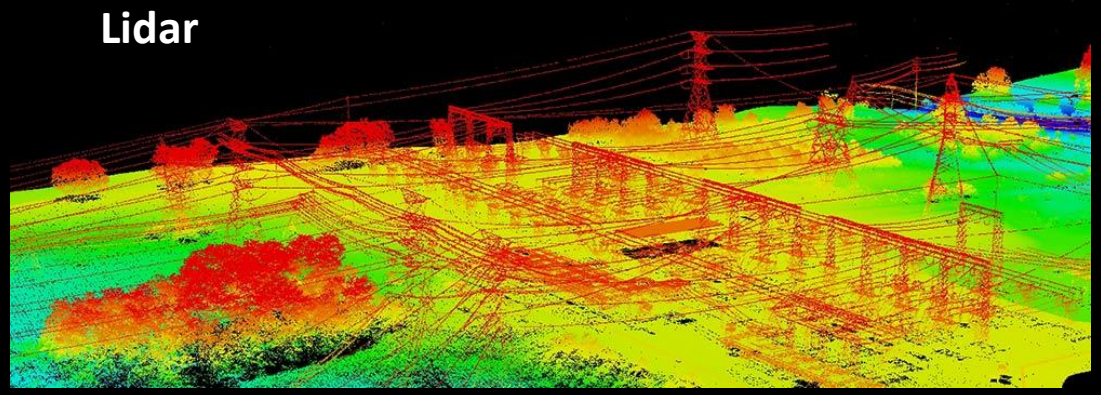
Choosing the right sensor

- RGB
- Thermal
- Multispectral
- Hyperspectral
- Lidar



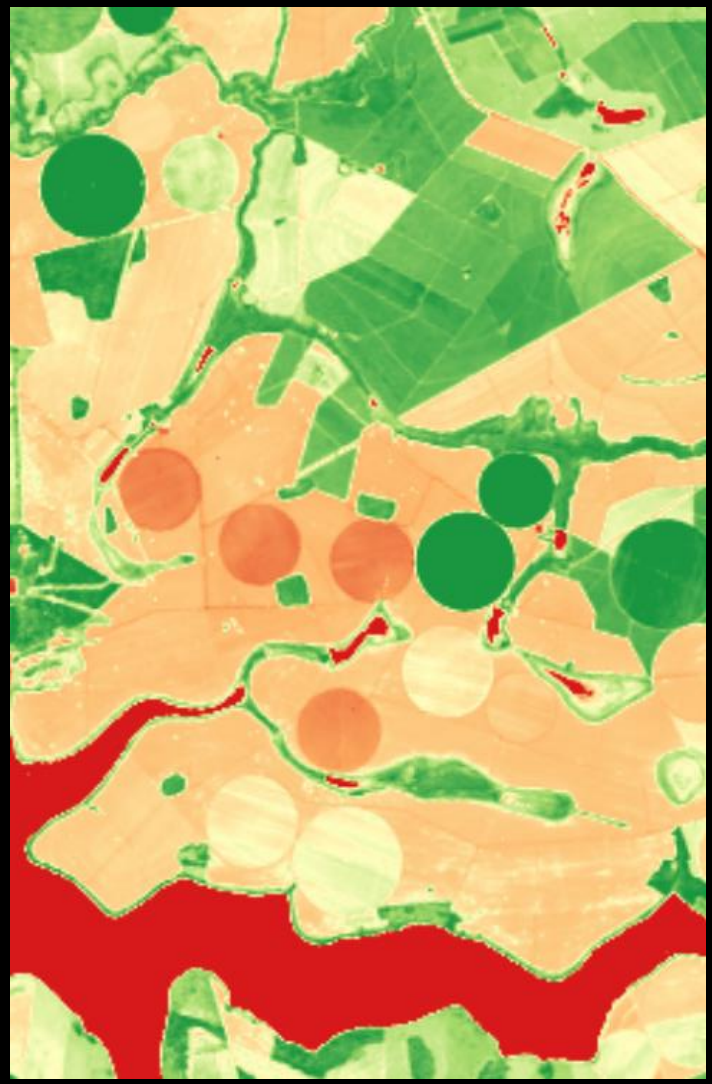






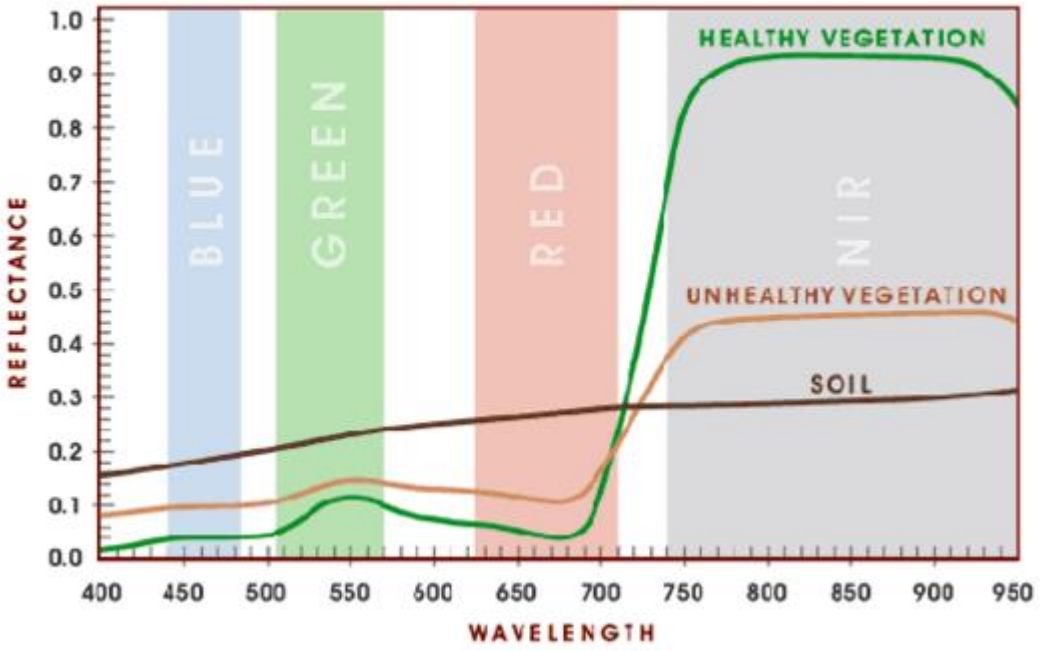
Vegetation indices

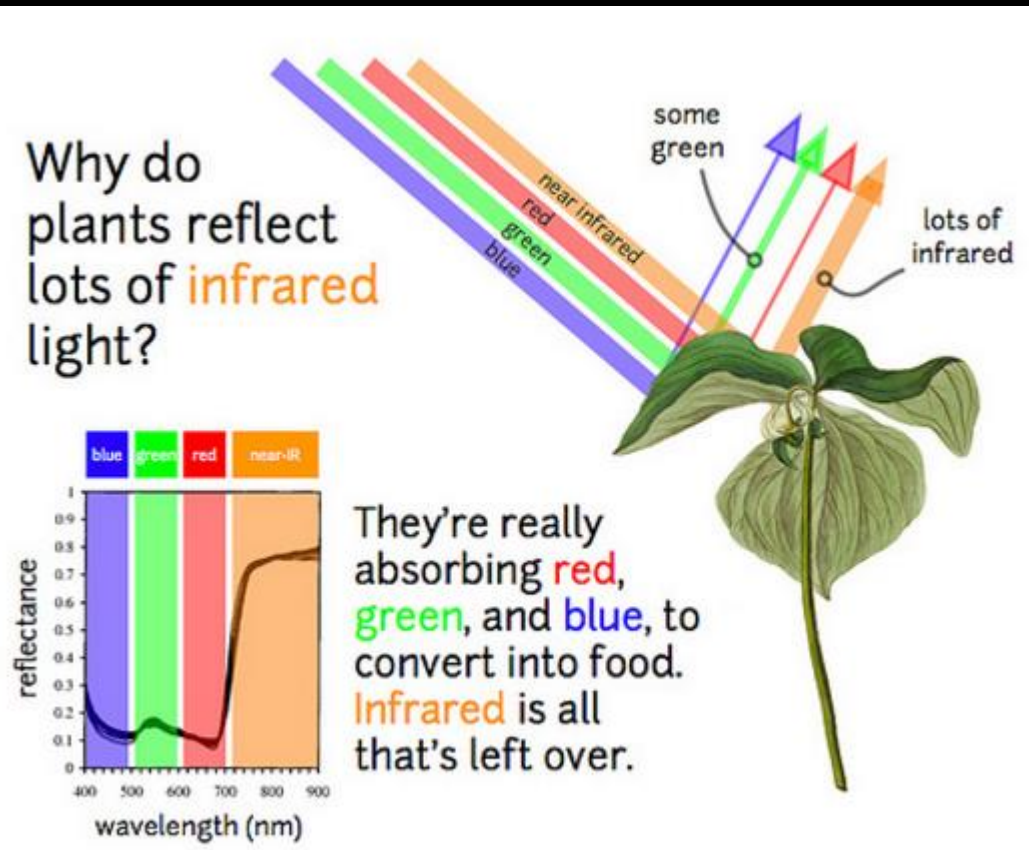
- Very useful for agricultural and environmental science
- Used to study plant canopy health
- Typically simple function of reflectances at two or more wavelengths



Vegetation index example: NDVI

- Normalized Difference Vegetation Index



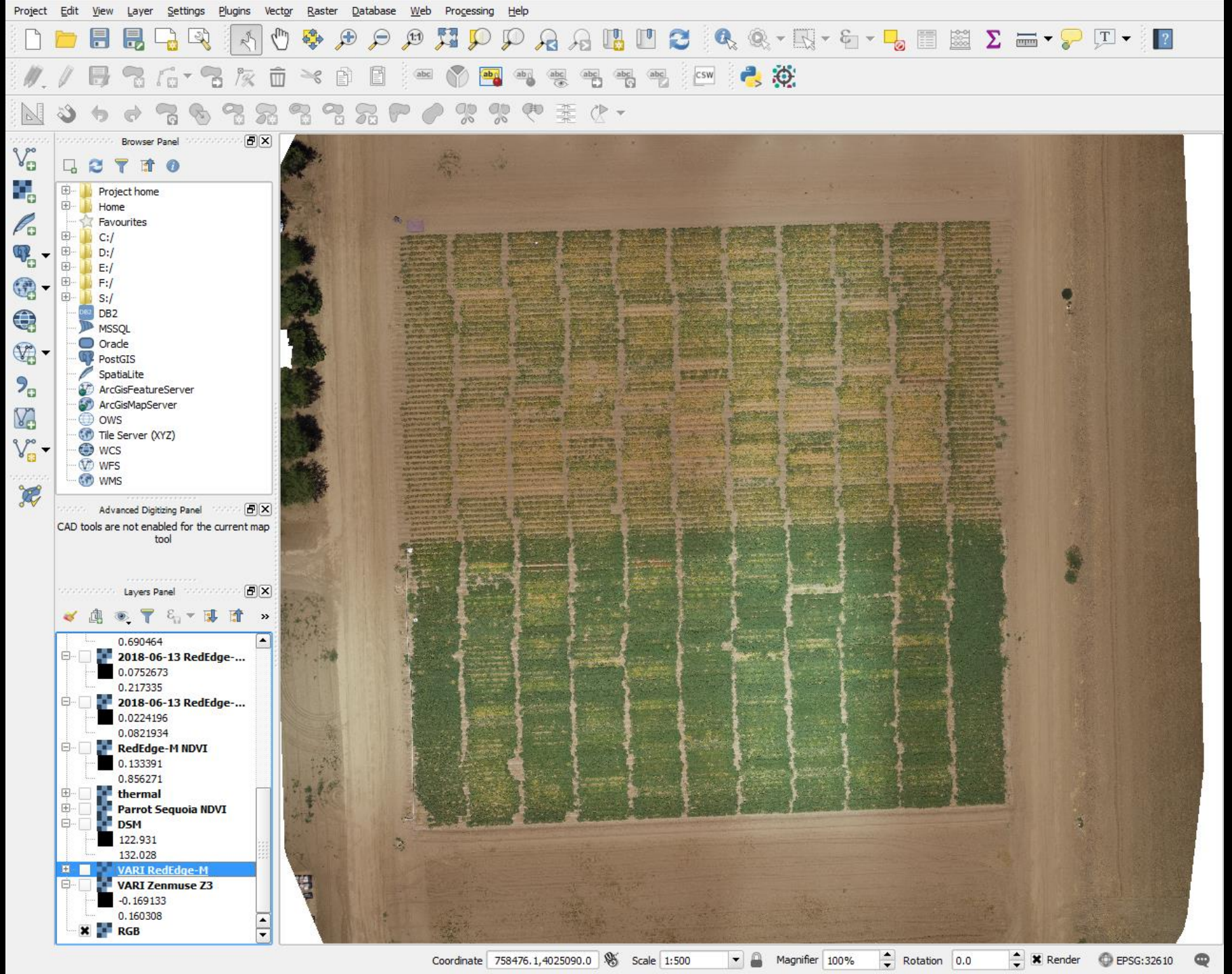


NDVI

- Examples:
- $(R_{NIR} – R_{red}) / (R_{NIR} + R_{red})$ (non-red variations exist)
- For very healthy plants:
  - (1-0) / (1+0) = 1
- For unhealthy/senescent plants:
  - (0.4-0.2) / (0.4+0.2) = 0.33
- Bare soil:
  - (0.2-0.2) / (0.2+0.2) = 0

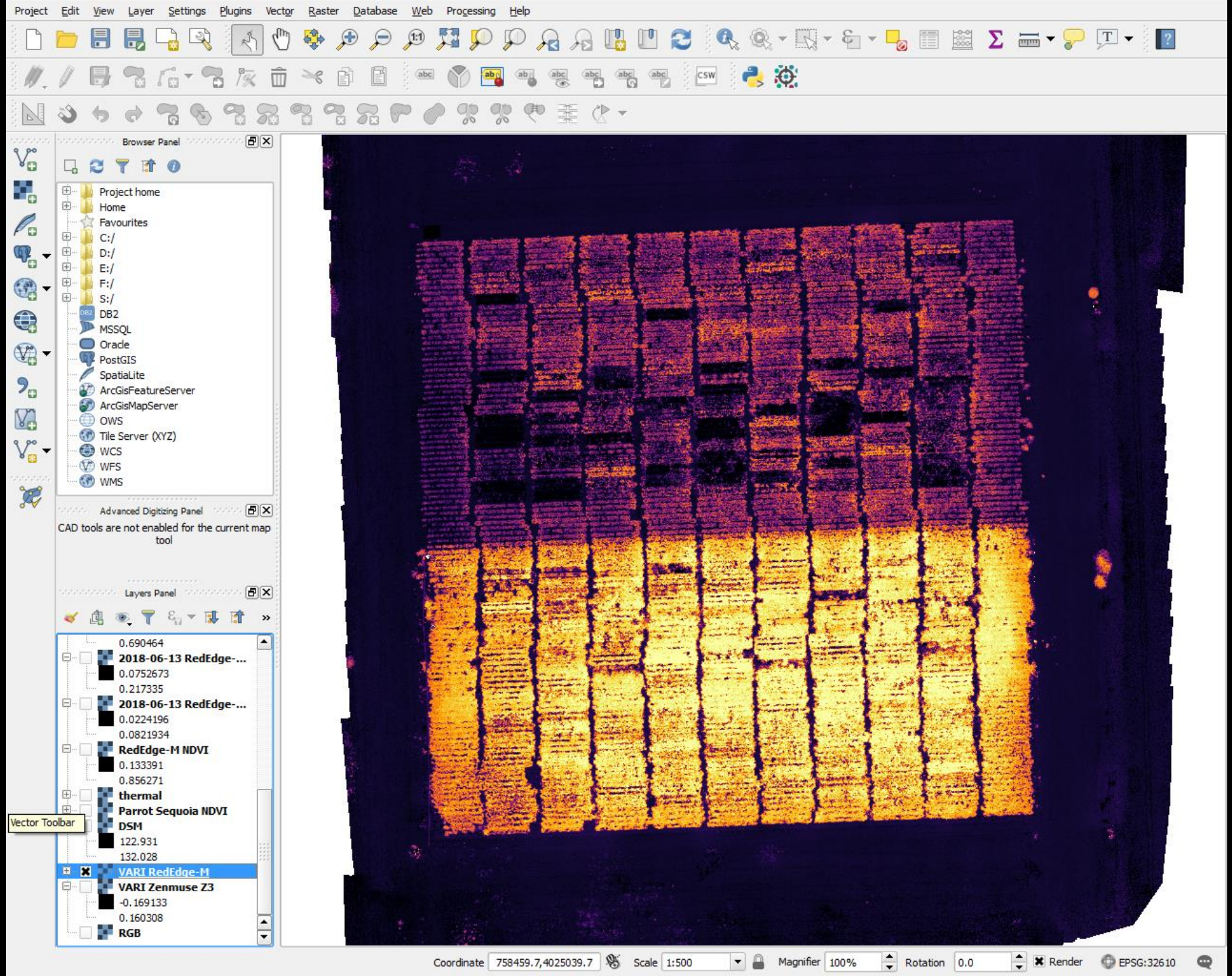
Sensors and vegetation indices

True-color (RGB)



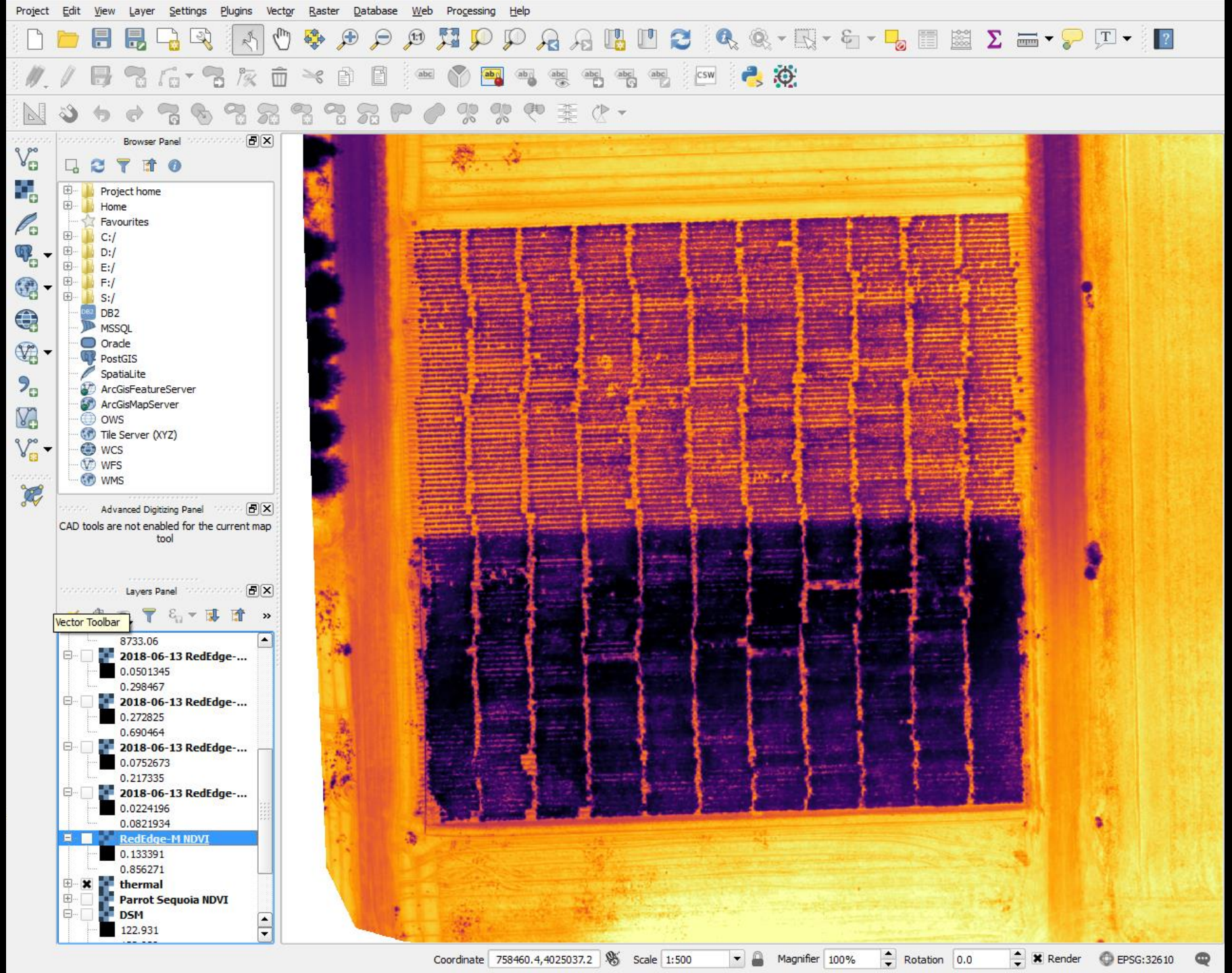
Sensors and vegetation indices

Health predicted by true-color (Visible atmosphic resistant index, VARI)



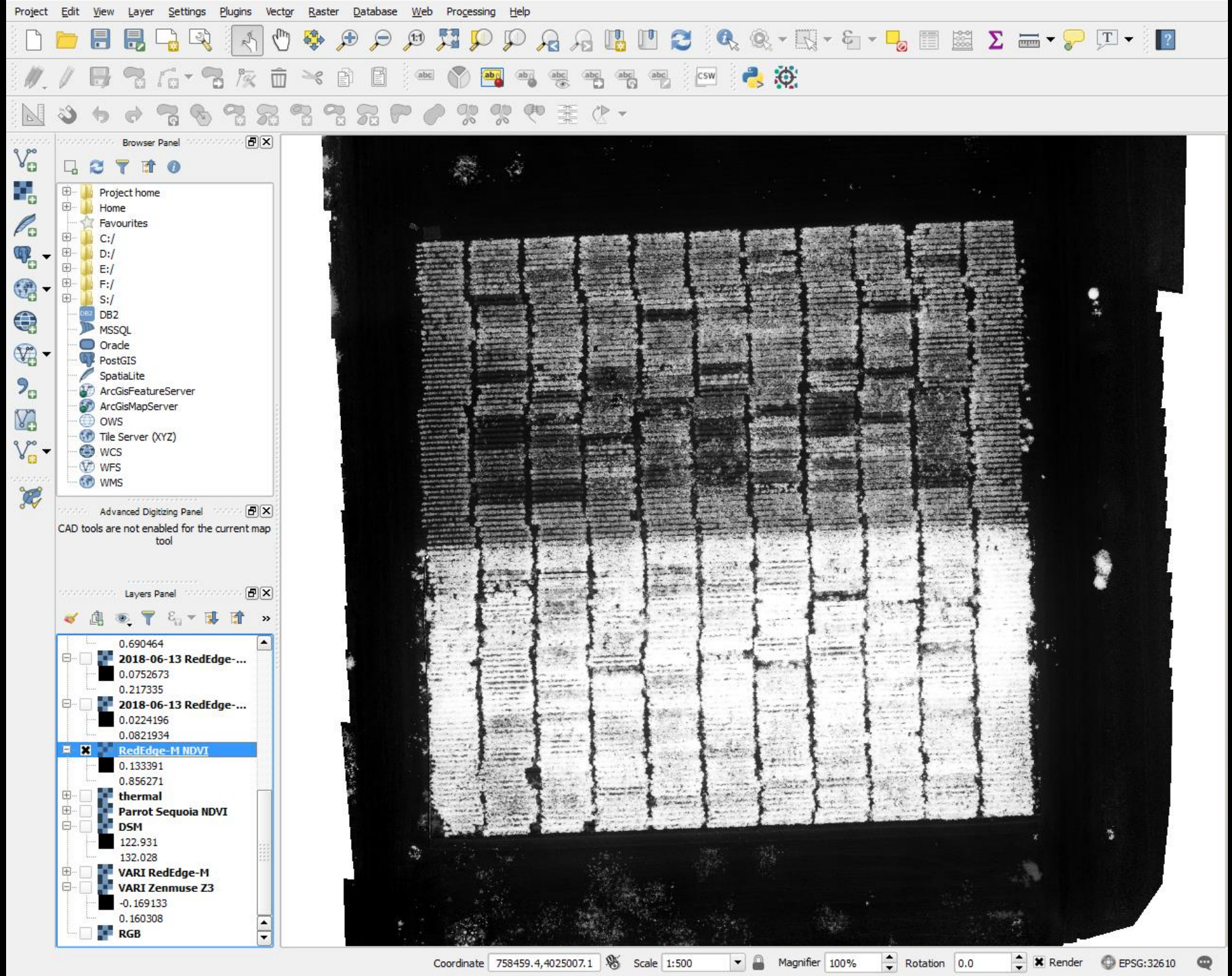
Sensors and vegetation indices

Thermal (IR)



Sensors and vegetation indices

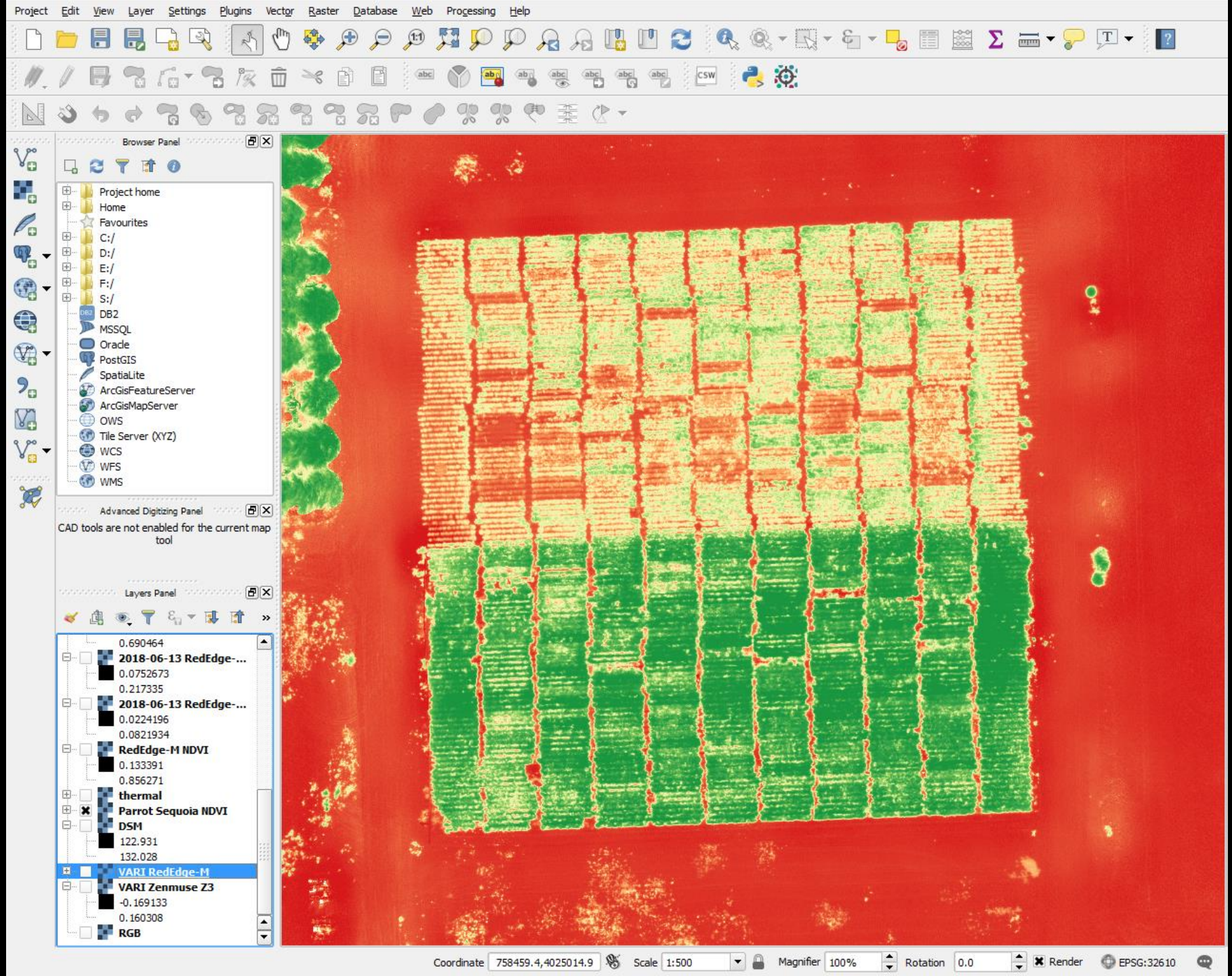
Health predicted by infrared and true color



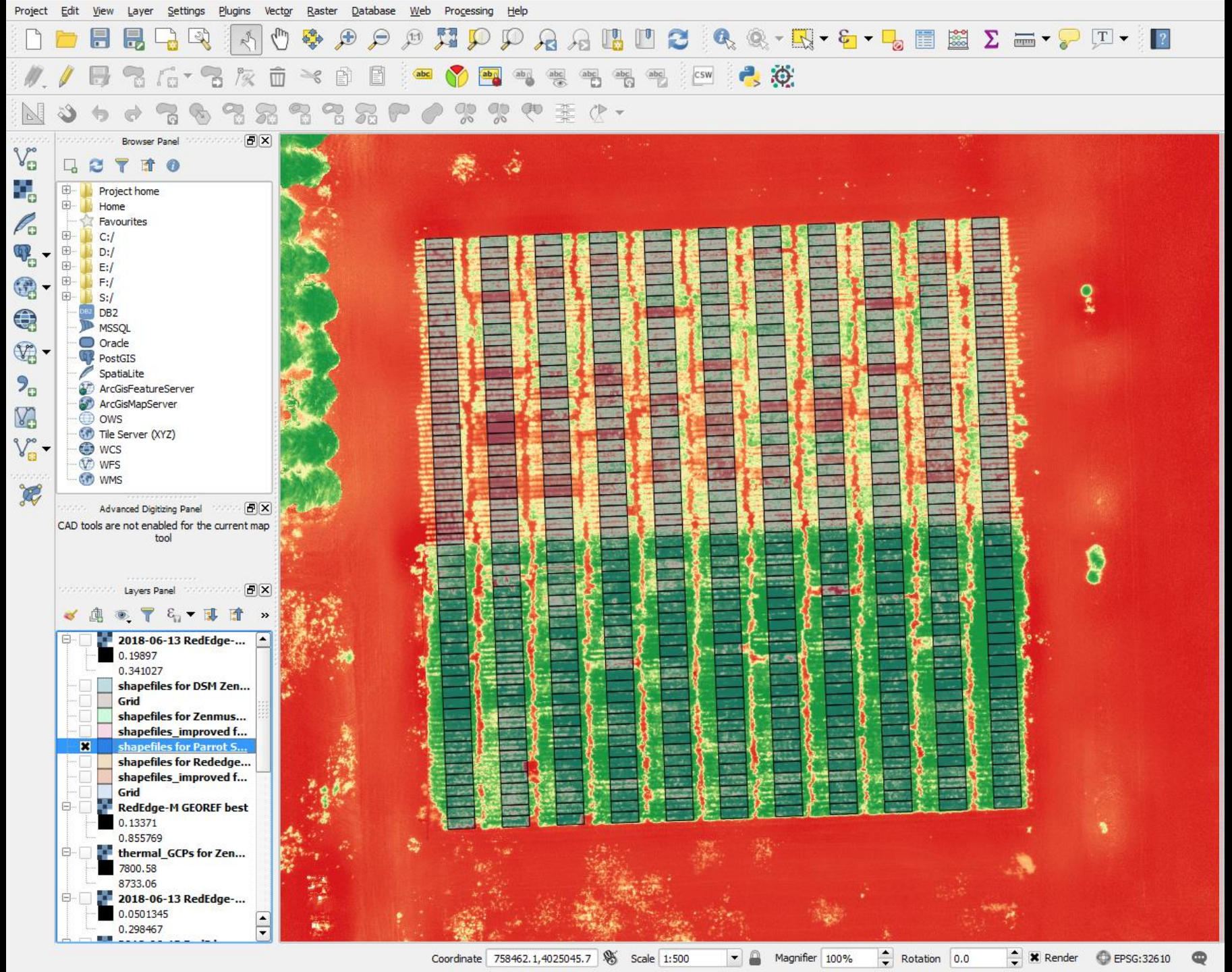
Sensors and vegetation indices

Health predicted by infrared and true color

(different camera)



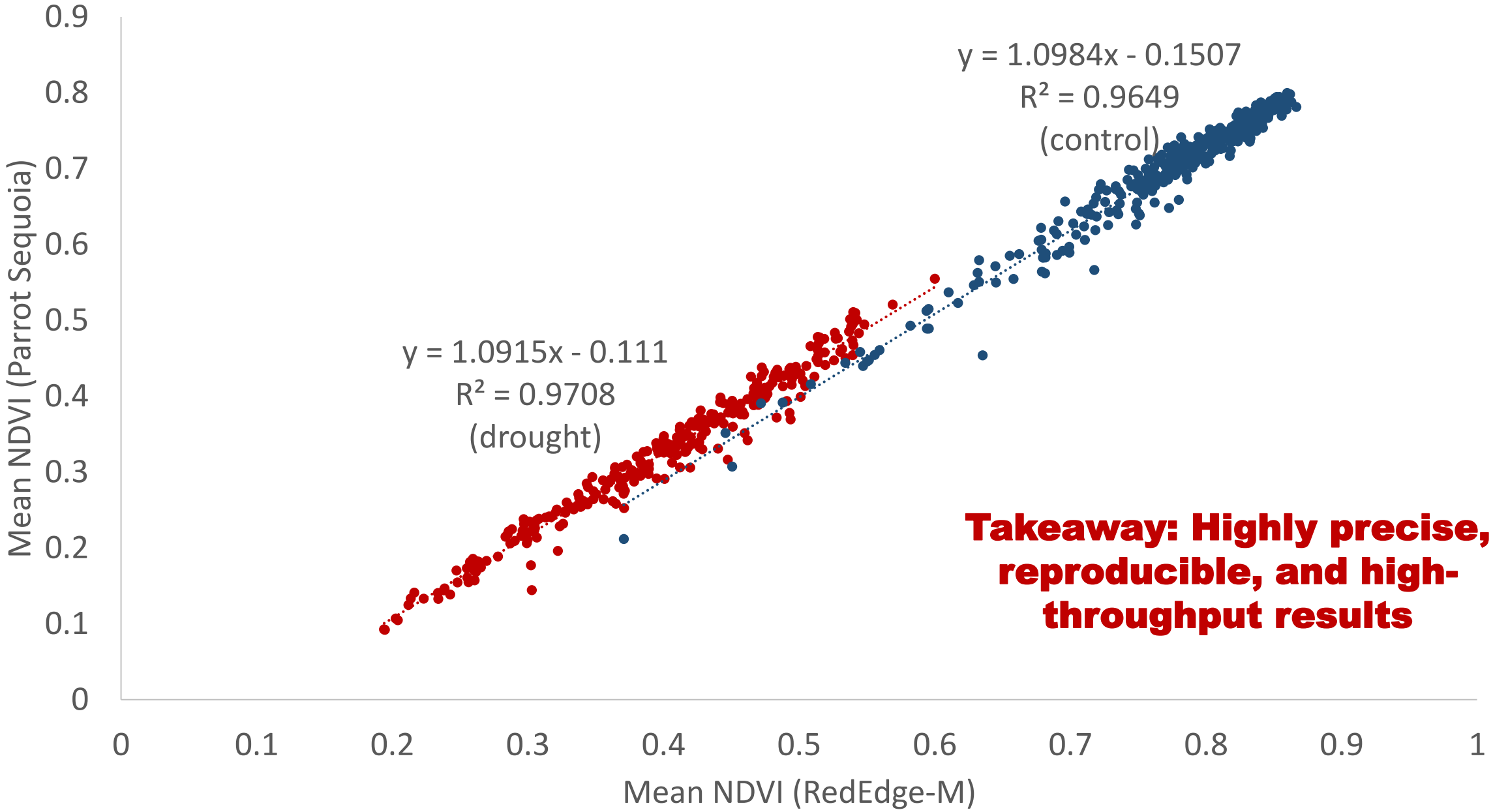
Sensors and vegetation indices



Health predicted by infrared and true color

(different camera)

+shapefiles for data extraction


y = 1.0984x - 0.1507
R² = 0.9649
(control)
y = 1.0915x - 0.111
R² = 0.9708
(drought)
Takeaway: Highly precise, reproducible, and high-throughput results
Mean NDVI (Parrot Sequoia)
Mean NDVI (RedEdge-M)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Summary (before we start QGIS)…

- Drones are useful for many different applications
- Drones collect highly precise, high-throughput data, which was out of reach just a few years ago
- Commercial drone use is projected to expand rapidly in coming years

For more information on Drone Services Fiji, visit:
https://www.droneservicesfiji.com.fj/

Thanks!

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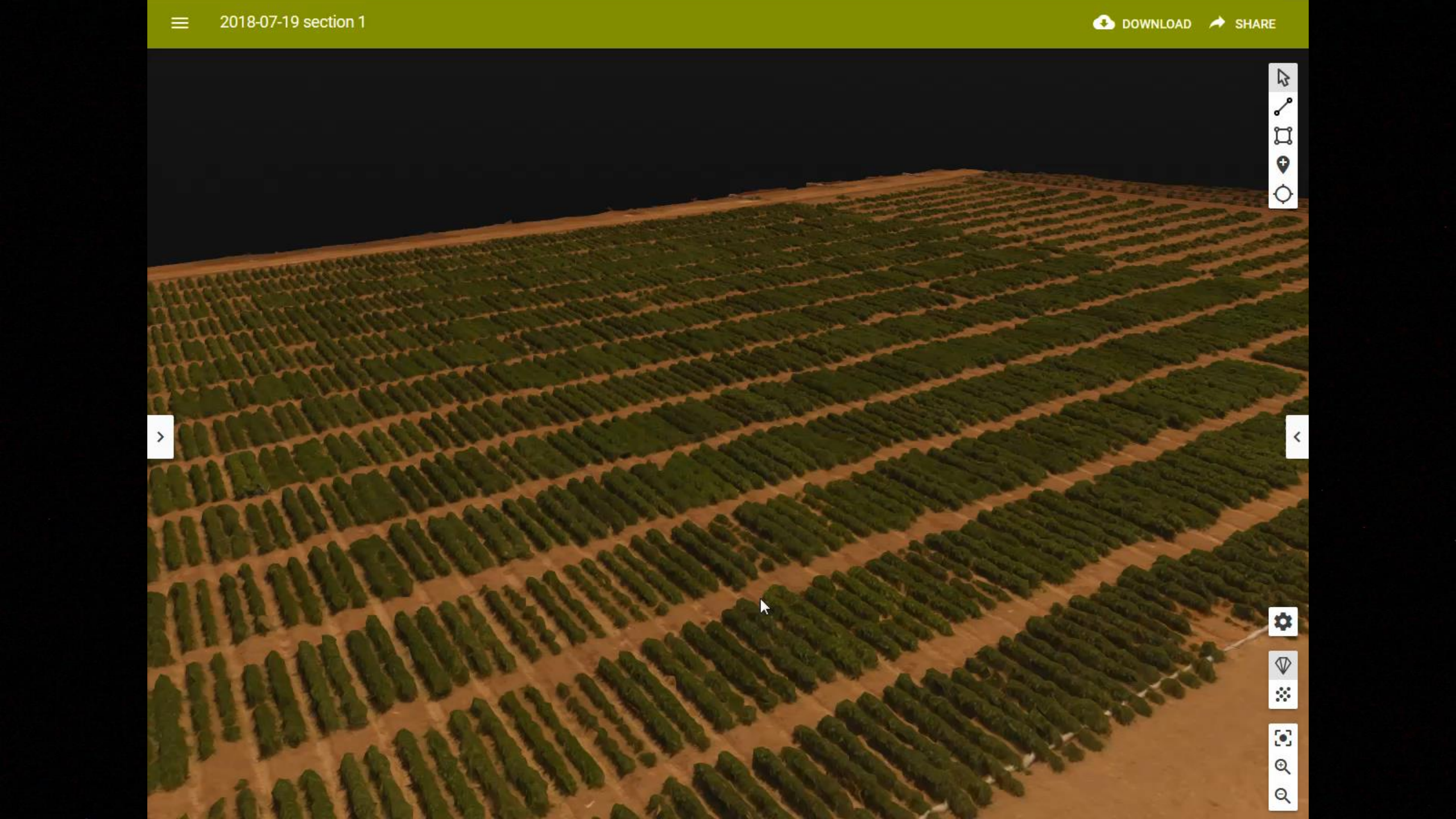
USDA
United States Department of Agriculture
National Institute of Food and Agriculture

WESTERN SARE
Sustainable Agriculture Research & Education

- (This and all following slides will almost certainly be cut)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