

# UAVs for Rivers, Ag, Forestry, & Ag-forestry

W. Cully Hession (VT-BSE)

Also: Brittany Grutter & Laura Lehmann (VT-BSE); Nicholas Polys (VT-ARC); Jonathan Resop (UMD); John Munsell & Matthew Sumnall (VT-FREC); Peter Sforza & Haitao Wang (VT-CGIT); others



# Explorations with a UAV-Based LiDAR

- Before
  - Surveying & TLS
  - UAV w/Aerial Images
- UAV/Drone System
- LiDAR System
- Applications
  - Streams & Floodplains
  - Agricultur
  - Forestry
  - Agroforestry

# The UAV/Drone



Pulse Aerospace Inc.

**VAPOR35**

Gross Weight: 30 lbs  
Useful Load: 16 lbs  
Allowable Payload: 5 lbs\*  
Cruise Endurance: 60 Minutes  
Hover Endurance: 45 Minutes



DJI Mavic Pro – 4k video/imagery



## Precision Mapping Payload

- Hi-res camera, mounting brackets, integration & trigger software
- Meta data file for geo-referencing (aircraft position and attitude angles) for each picture

# We plan, it flies

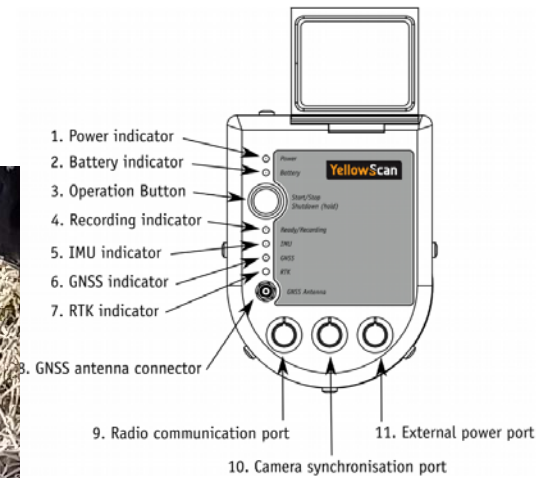
The screenshot shows a flight planning software interface titled "Catawba Tree Planting". The main window displays a top-down map of a field with a grid of waypoints numbered 1 through 38. A green line indicates the planned flight path, starting from a "START" point and ending at a "HOME" point. The interface includes a menu bar at the top with options like "View", "Map control", "Map", "Profile", "Infos", "Full Screen", "Options", "Help", and "Exit". On the left, there are status indicators for "Wind" (0.0m/s), "AGL" (0m), and "DTED". At the bottom, there are several instrument panels: a heading indicator, a ground speed (Gnd) meter in m/s, a throttle position indicator, an altitude meter in meters, a temperature gauge in degrees Fahrenheit, and an RPM gauge. On the right side, there is a "Mission Editor" panel with a list of waypoints: "START", "HOME", "1-STOP", "2-HIPPODROME", "3-STOP", "4-CRUISE", "5-CRUISE", "6-CRUISE", and "7-CRUISE". Below the list are buttons for "Edit", "Add", and "Del". At the bottom of the right panel, there are buttons for "Upload Mission", "Save", and "Close".





# The LiDAR System

- YellowScan® Surveyor Core System
- Integrated w/Vapor35
- Multi-echo LiDAR sensor GNSS RTK + PPK receiver, bi-frequency L1/L2
- Calibrated IMU
- Embedded computer
- Data pre-processing software
  
- 1 to 2 returns
- ~400 pts/m<sup>2</sup> @ 20 m
- Data recorded to USB stick, includes:
  - IMU and GPS real-time recordings
  - Scanner data

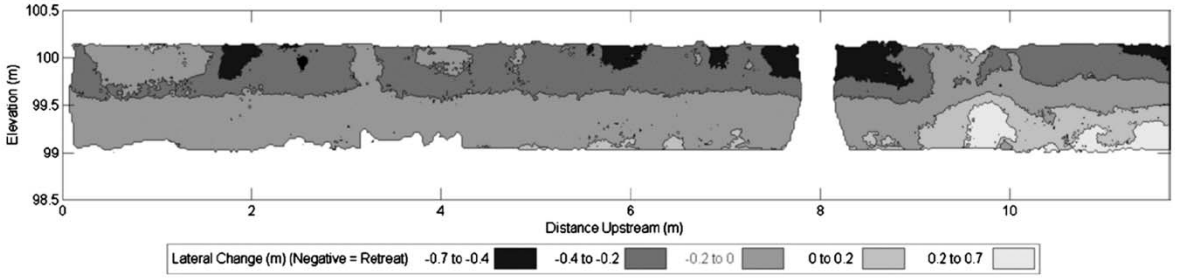
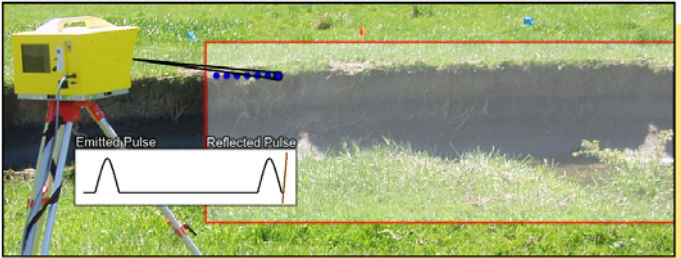


# Before UAV – Surveying & TLS

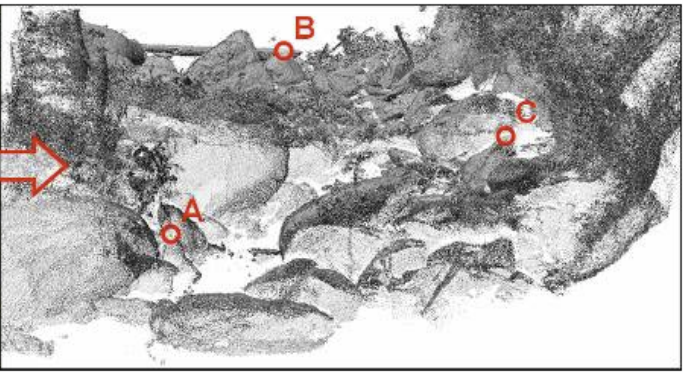
Geomorph



- Bank erosion

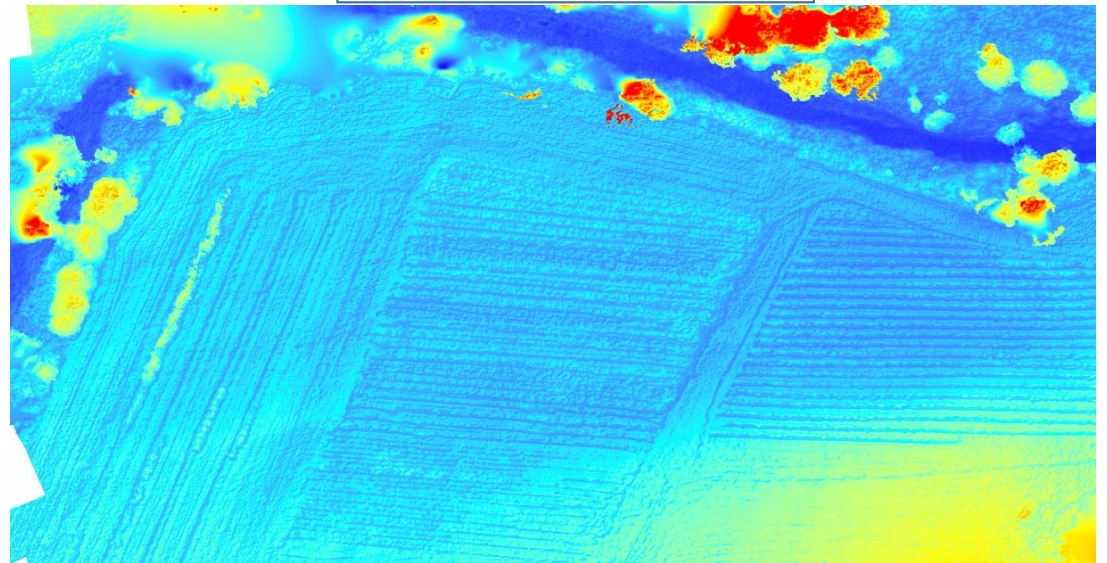
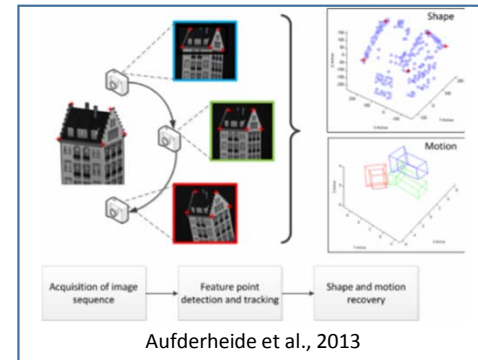


- Trout habitat





# Before LiDAR – Areal SfM



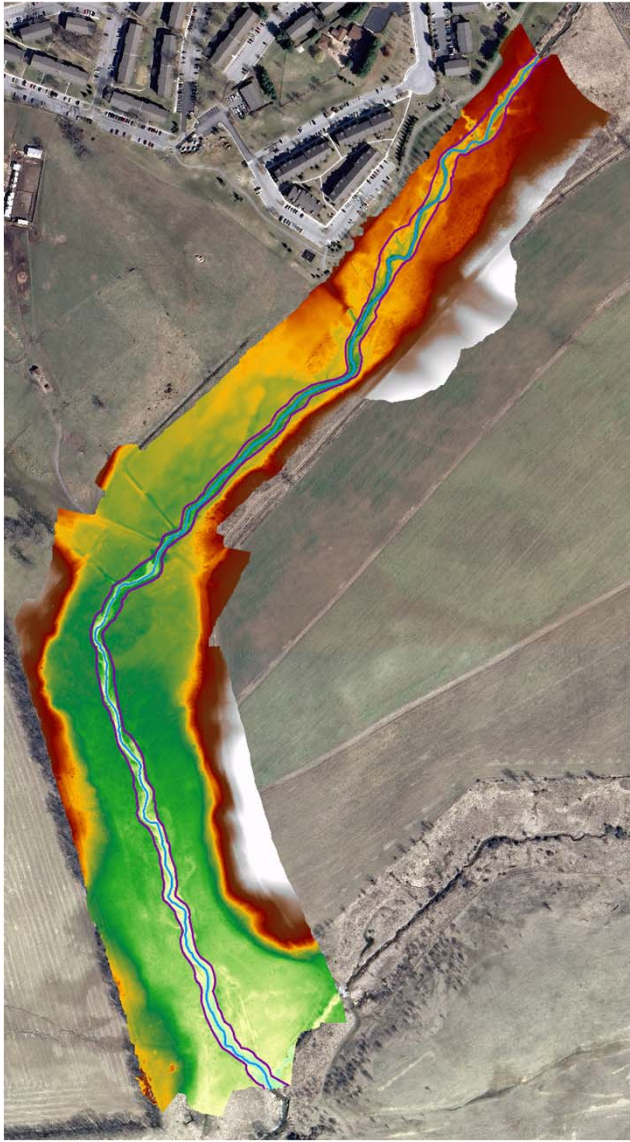
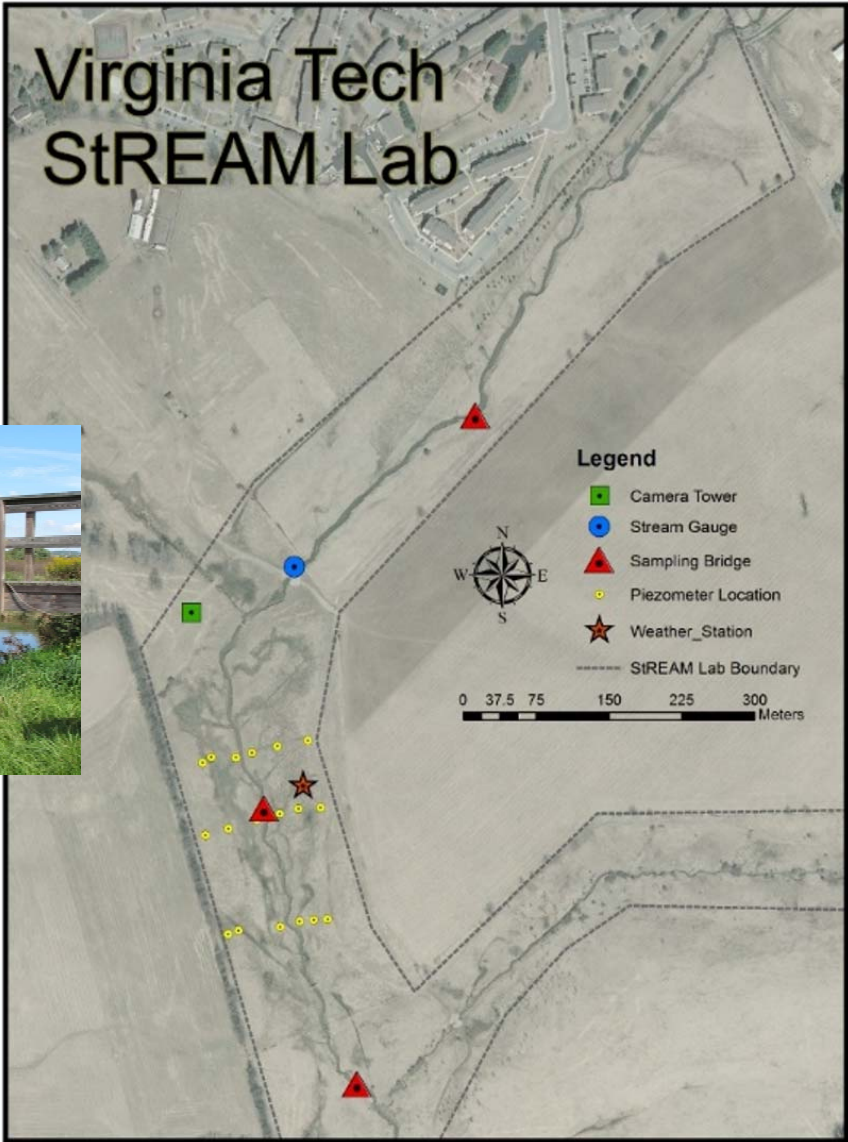
# Streams & Floodplains

- Channel morphology
- Aquatic habitat (% cover, shading, water surface width/area)
- Floodplain mapping/inundation
- Roughness
- Riparian vegetation
- Change in above over time....



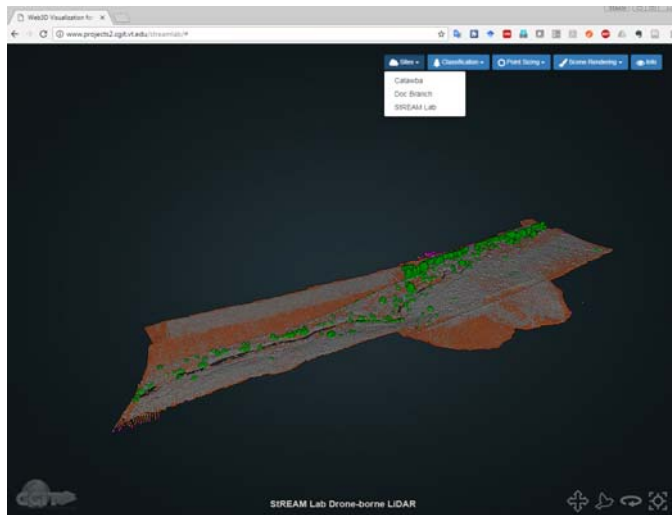
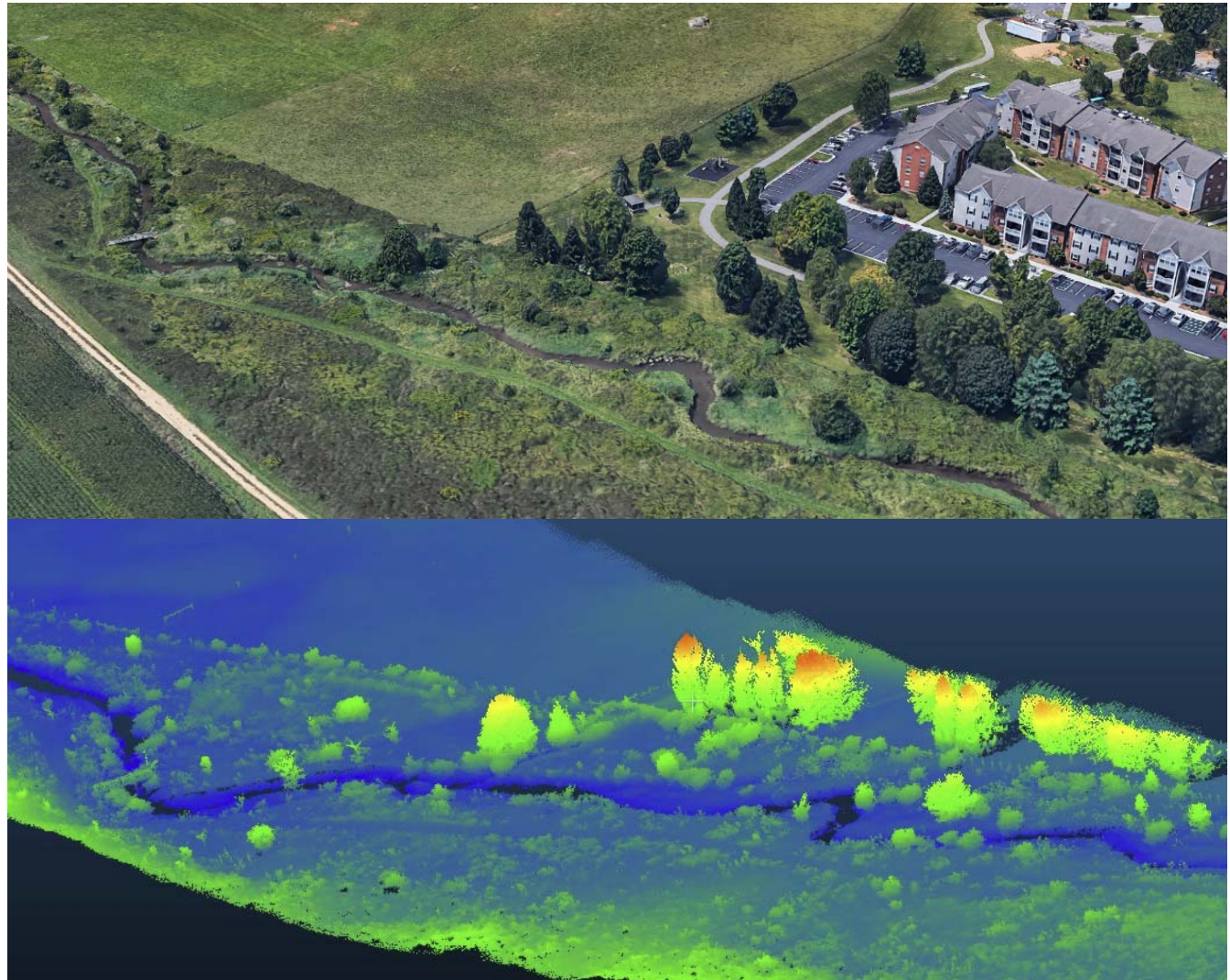


# StREAM Lab



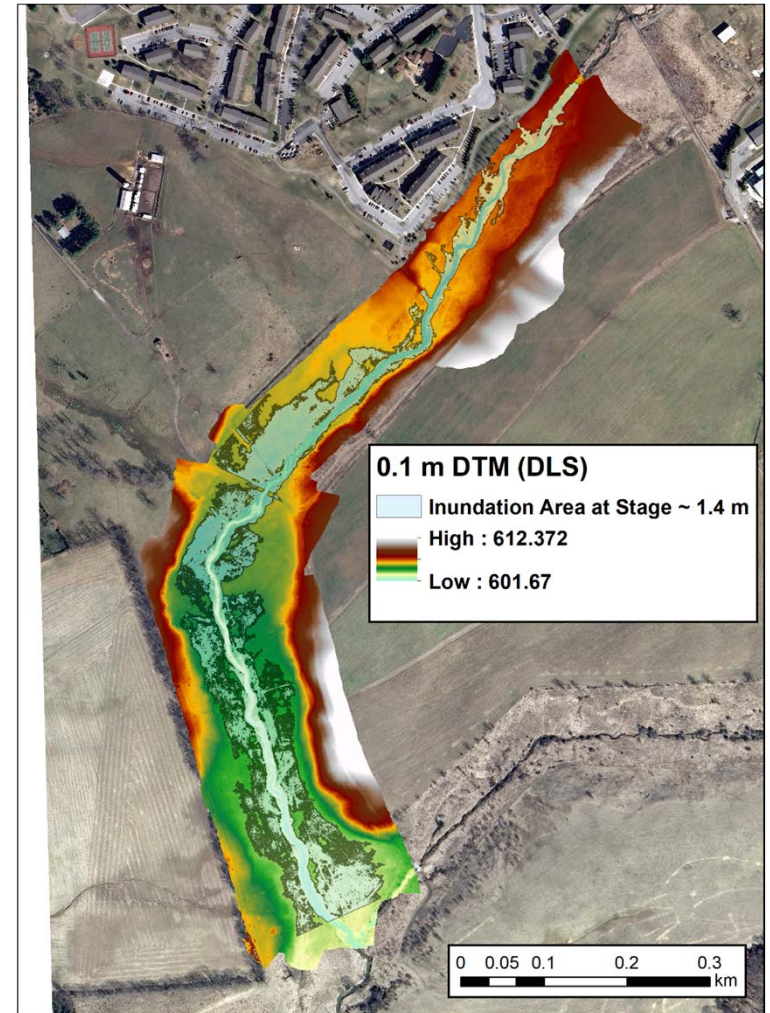
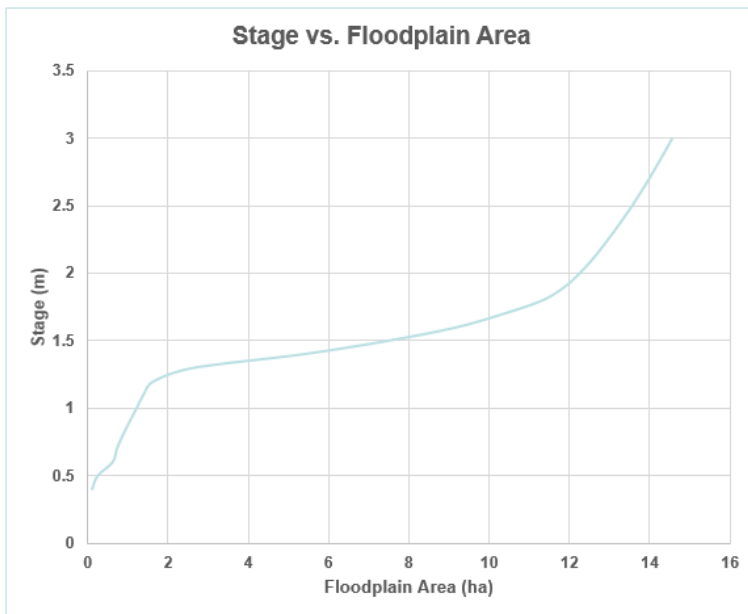


# Elevation of ground & vegetation



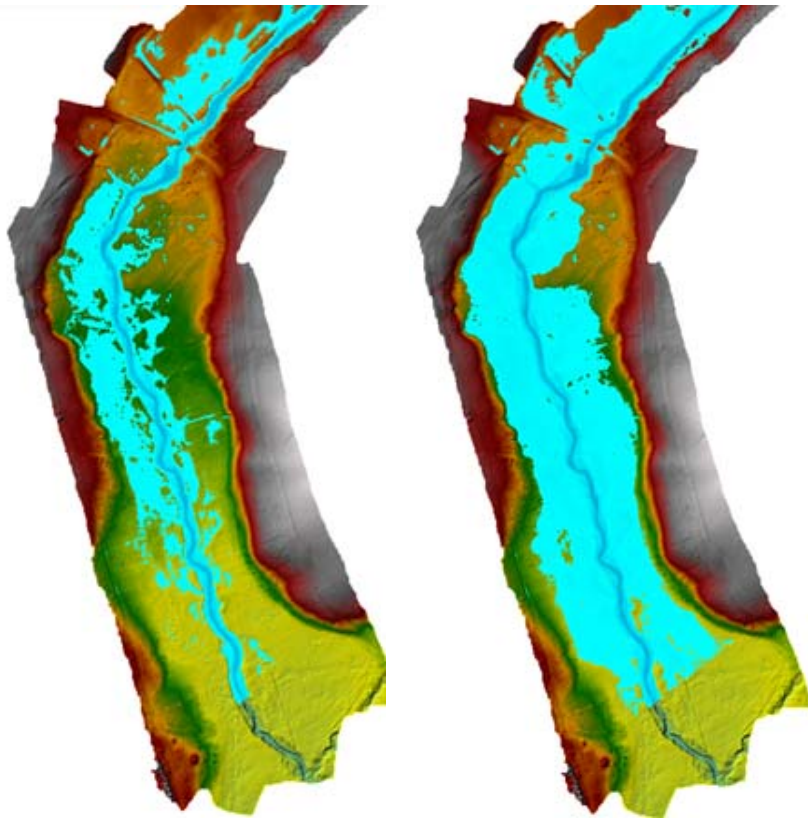
<http://www.projects2.cgit.vt.edu/streamlab/>

# Flood inundation modeling





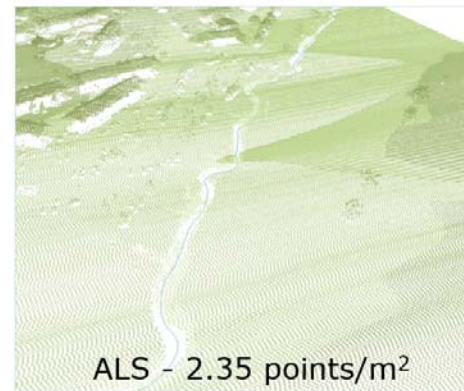
# Improved hydrodynamic modeling



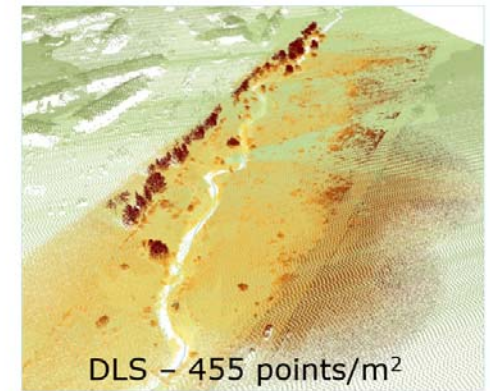
Low flow

High flow

## Comparison of Aerial Laser Scanning & DLS

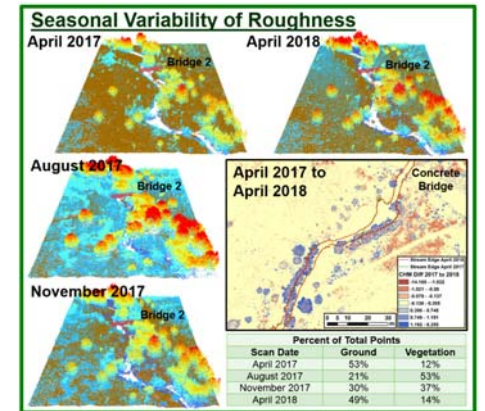
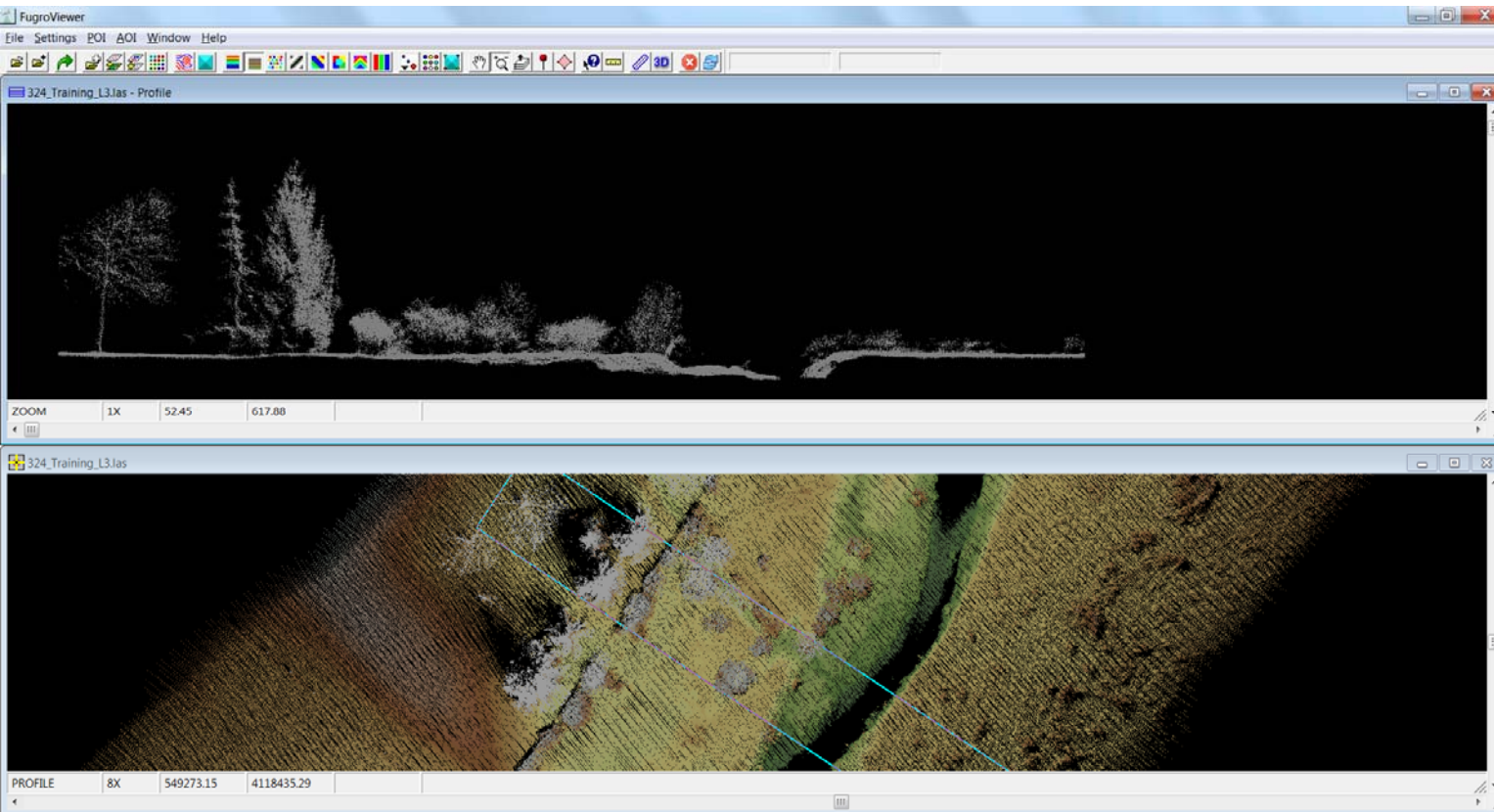
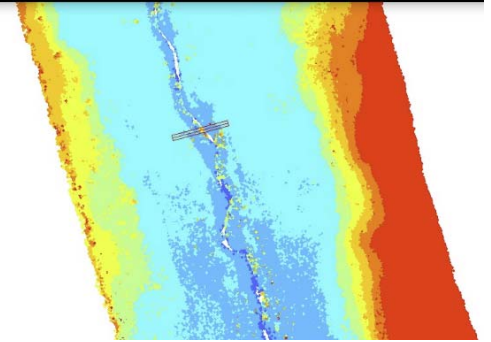
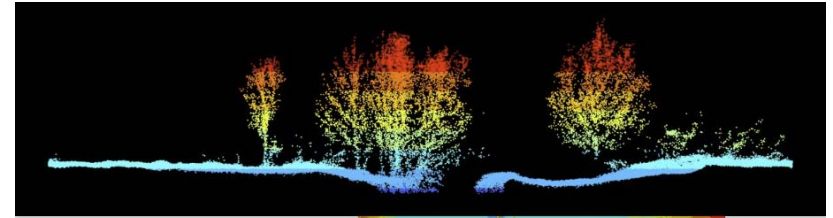


ALS - 2.35 points/m<sup>2</sup>



DLS - 455 points/m<sup>2</sup>

# Roughness?



# Agriculture - Measuring Forage Quality

- W. Cully Hession (VT-BSE), Vitalis W. Temu (VSU), Peter Sforza, Haitao Wang (VT-CGIT)
- DLS for assessing native warm-season grass responses to grazing
- Lidar for forage biomass, sward heights, and ground cover estimates
- Randolph Farm, Virginia State Univ., Petersburg, VA





# Collecting Data



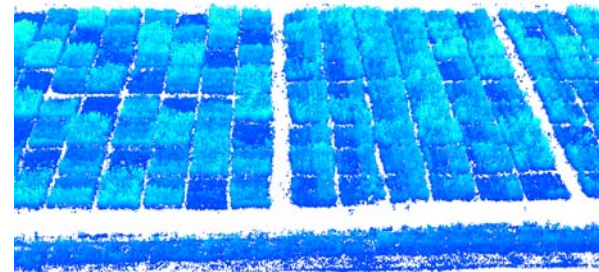
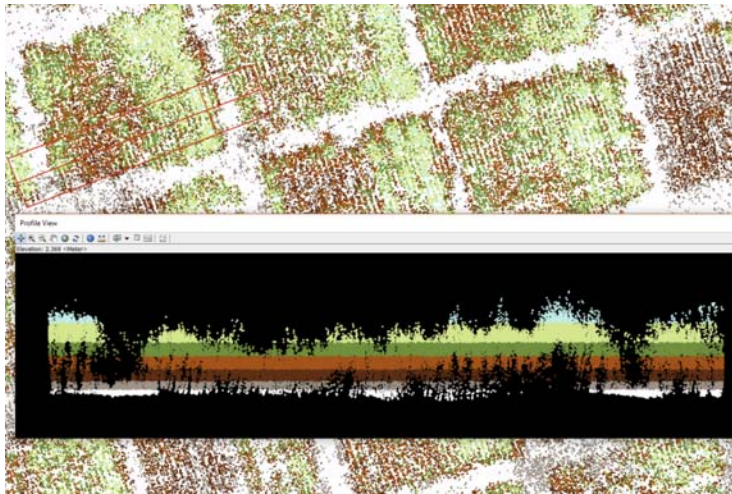
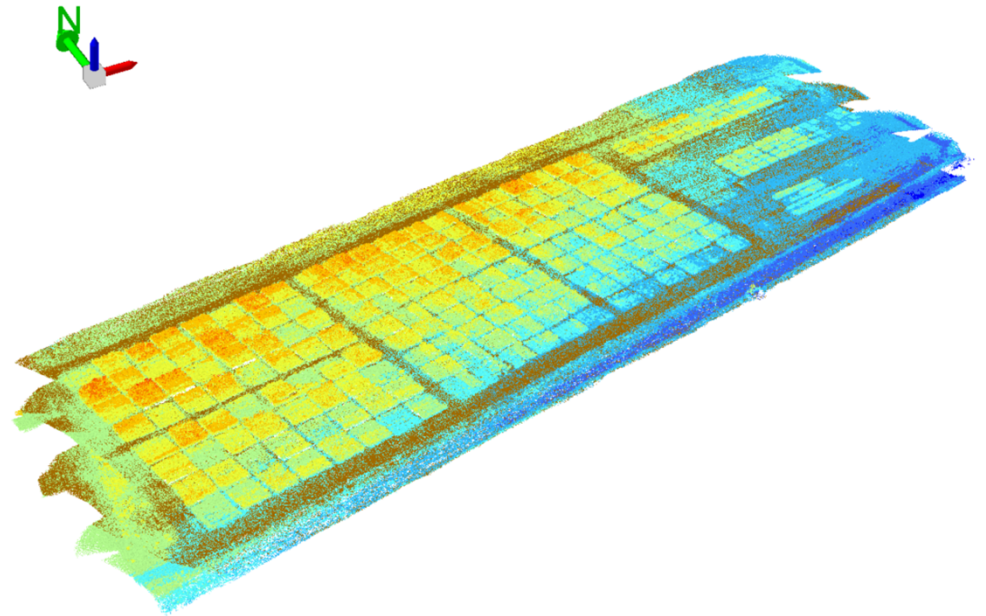
May 1, 2018



June 4, 2018



# Lidar point clouds, forage properties



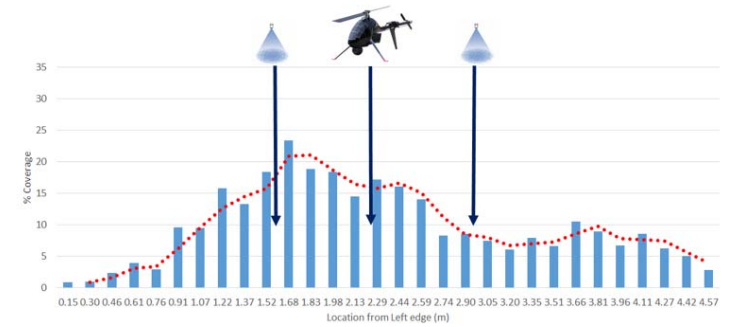
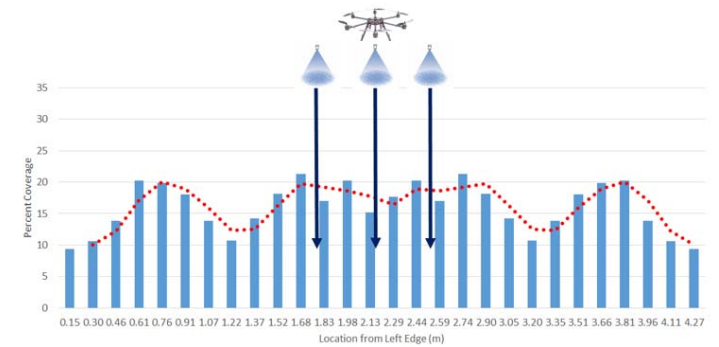
# UAVs for Aerial Spraying

- Funded by DuPont (now DowDupont)
- Collaboration w/VT-Unmanned Systems Lab (USL)
- Identify best management practices (BMPs) for UAVs in aerial spraying
- Evaluated height, nozzle position & type, UAV platform (single vs 6) combination for highest % coverage





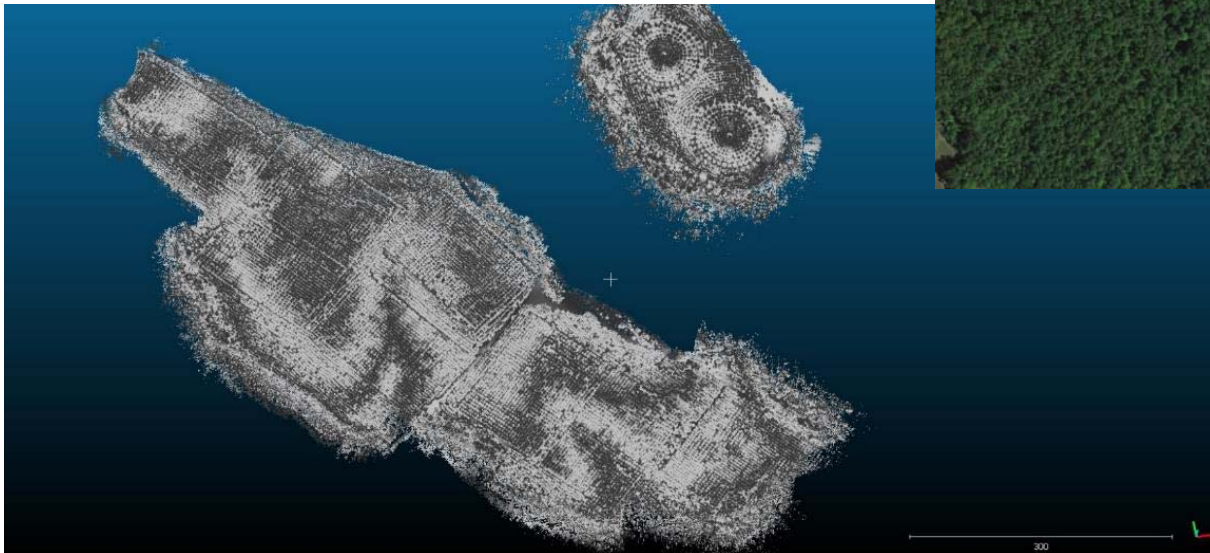
# Drones for ag spraying



# Forestry

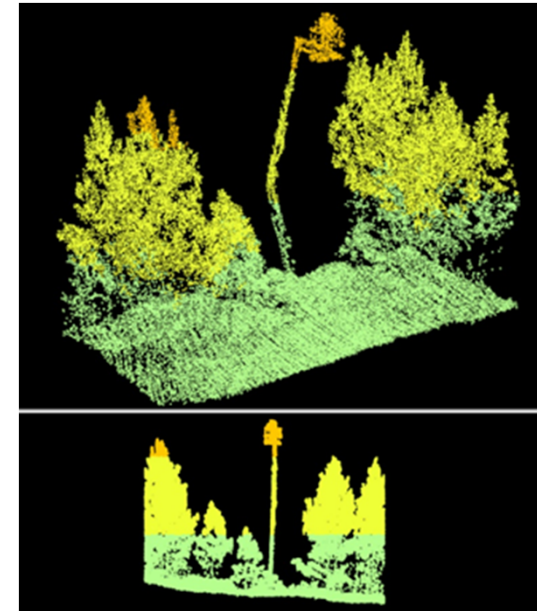
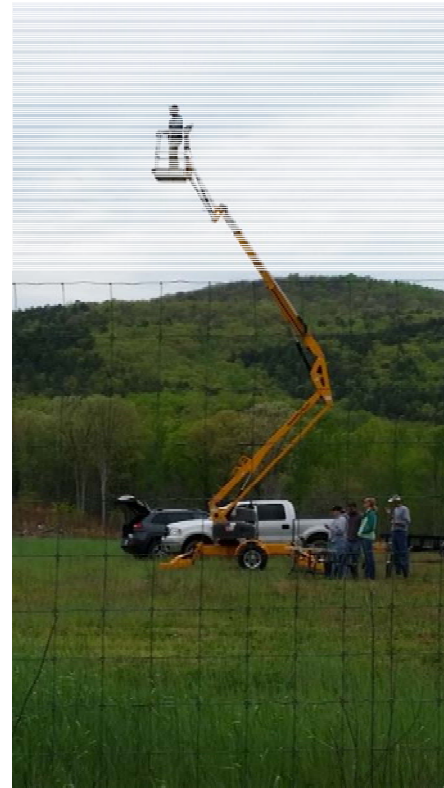
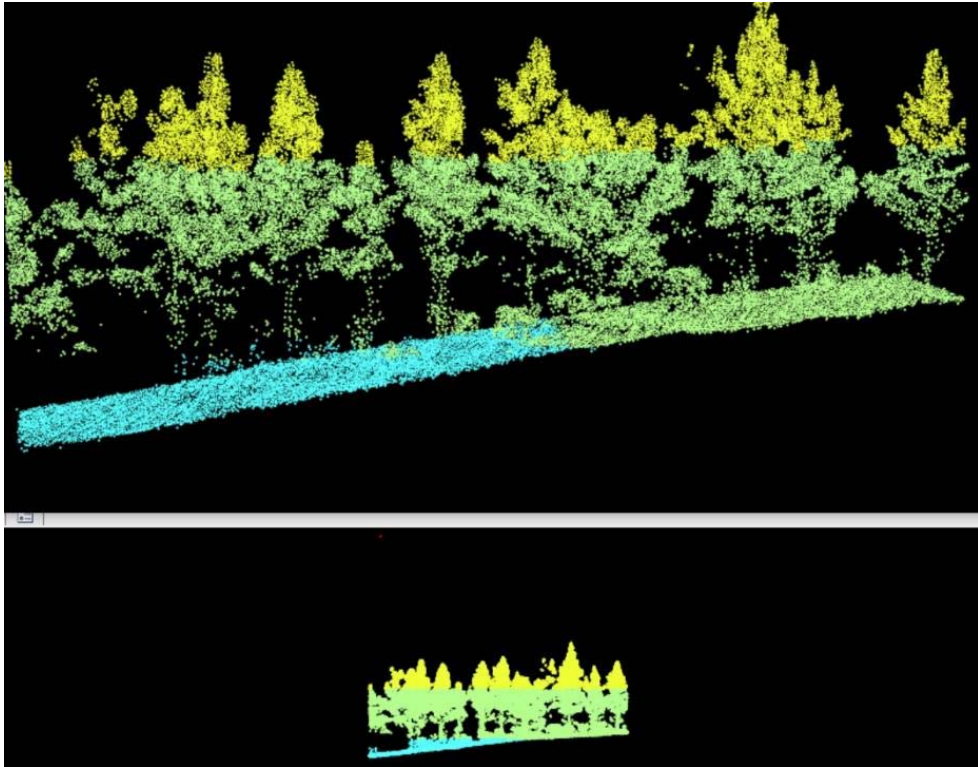
- Tom Fox & Matthew Sumnall, VT-FREC
- Forest productivity research
- Reynolds Homestead, VA & Bladen Lakes, NC
- Leaf area index (LAI), canopy height, biomass estimates
- Change over time

# Reynolds Homestead



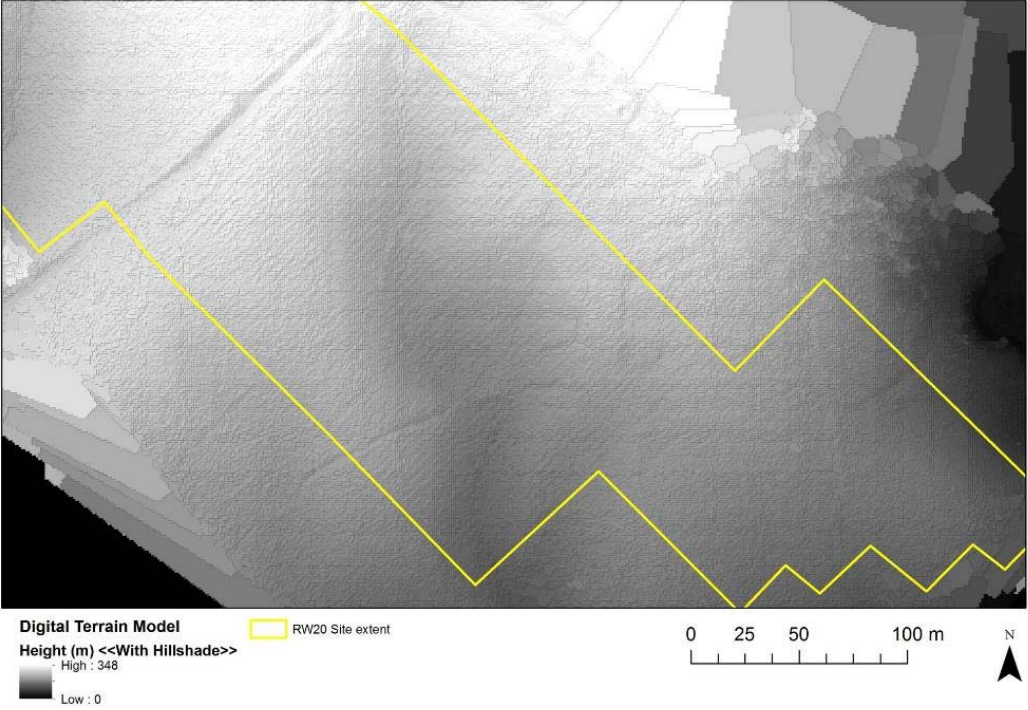


# Leaf area index, canopy structure, where's waldo, etc.

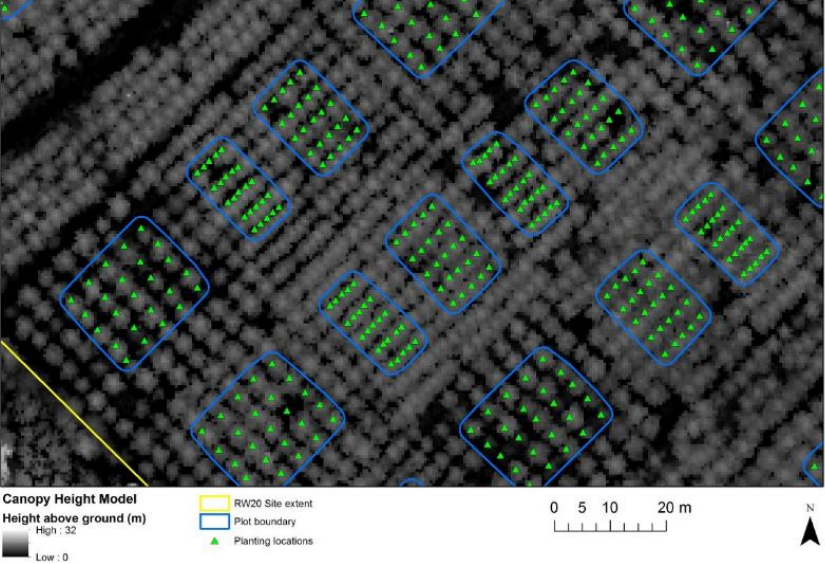


# Terrain, canopy height, etc.

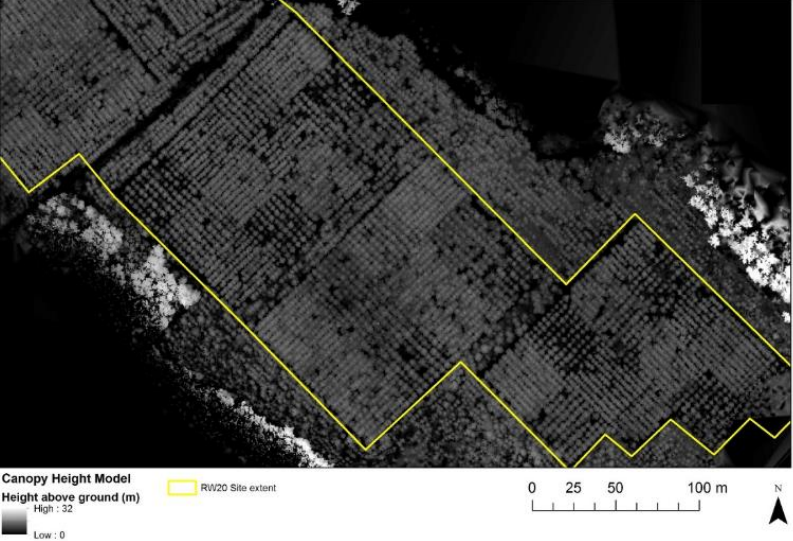
Reynolds Homestead VT research site (2017)



Reynolds Homestead VT research site (2017) - planting locations



Reynolds Homestead VT research site (2017)

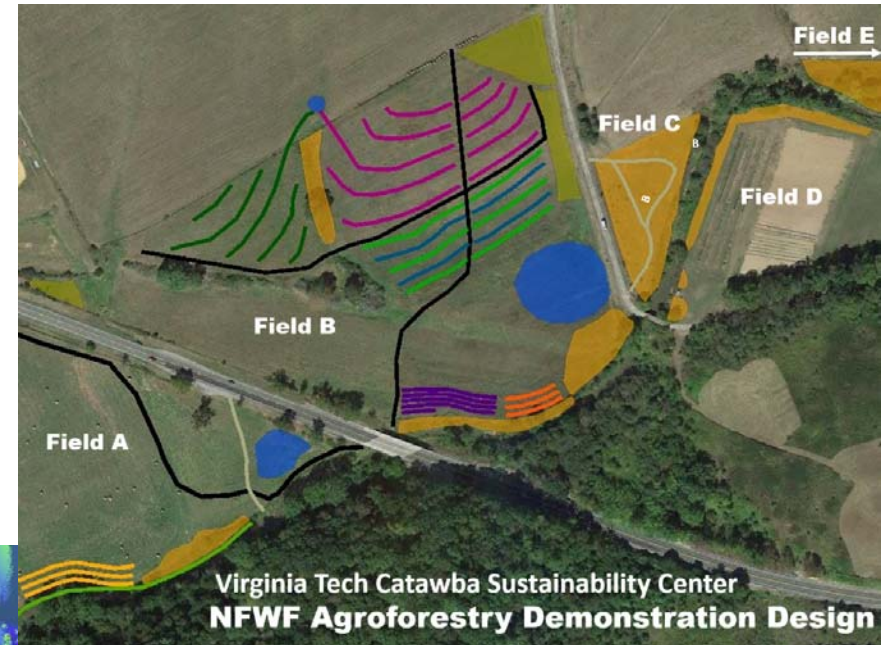
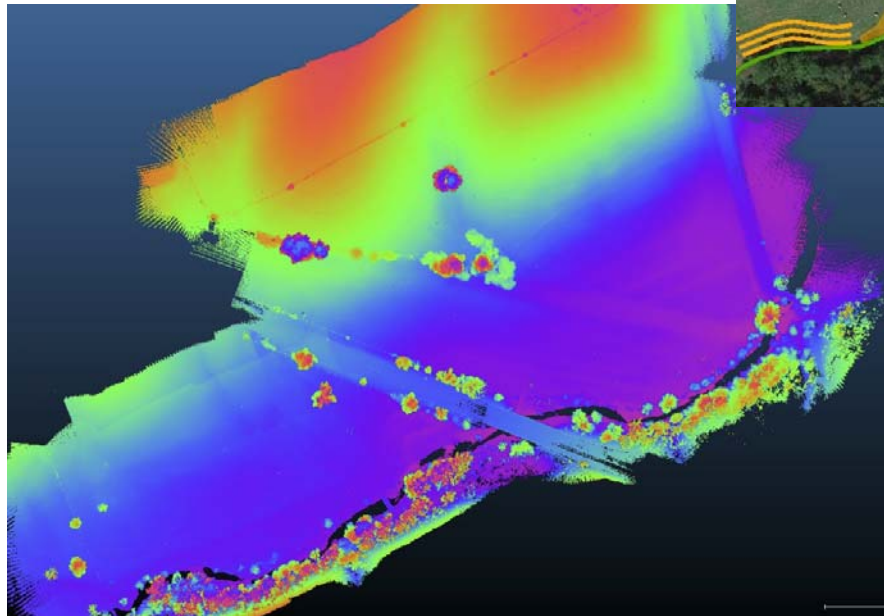




# Agroforestry

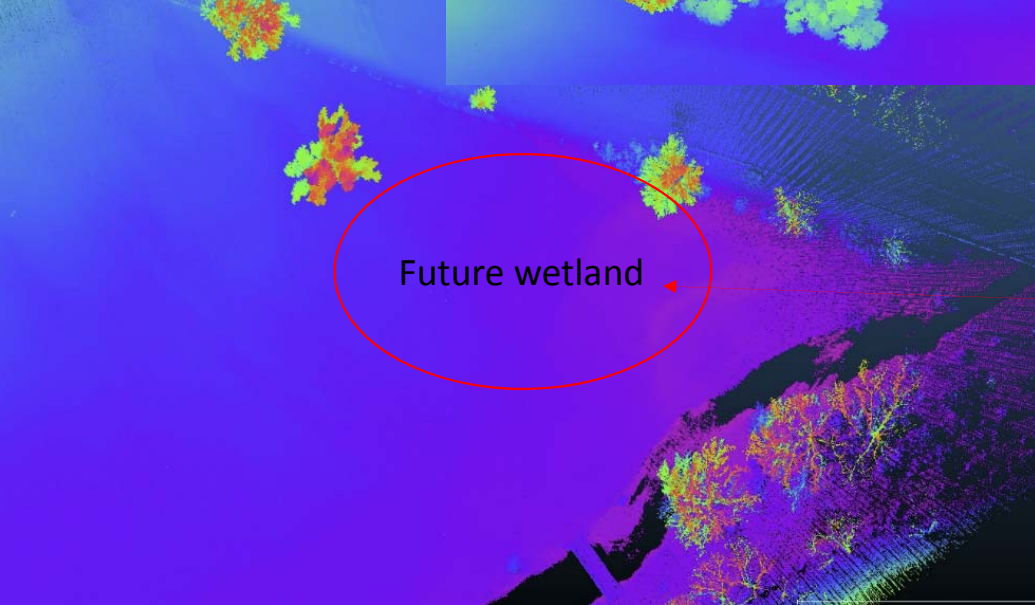
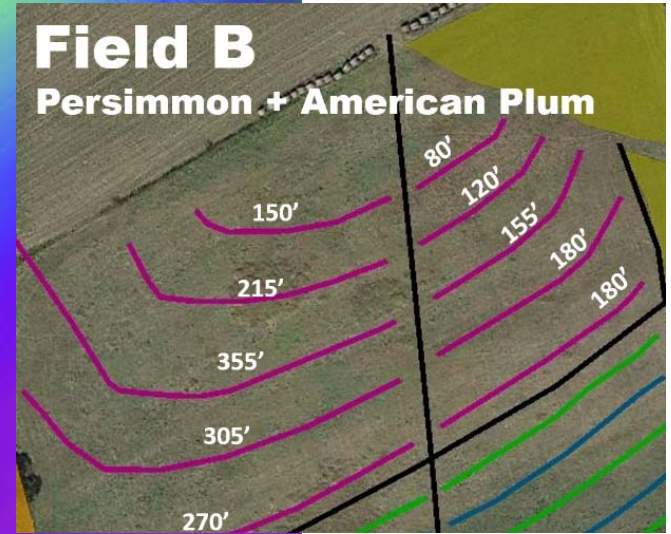
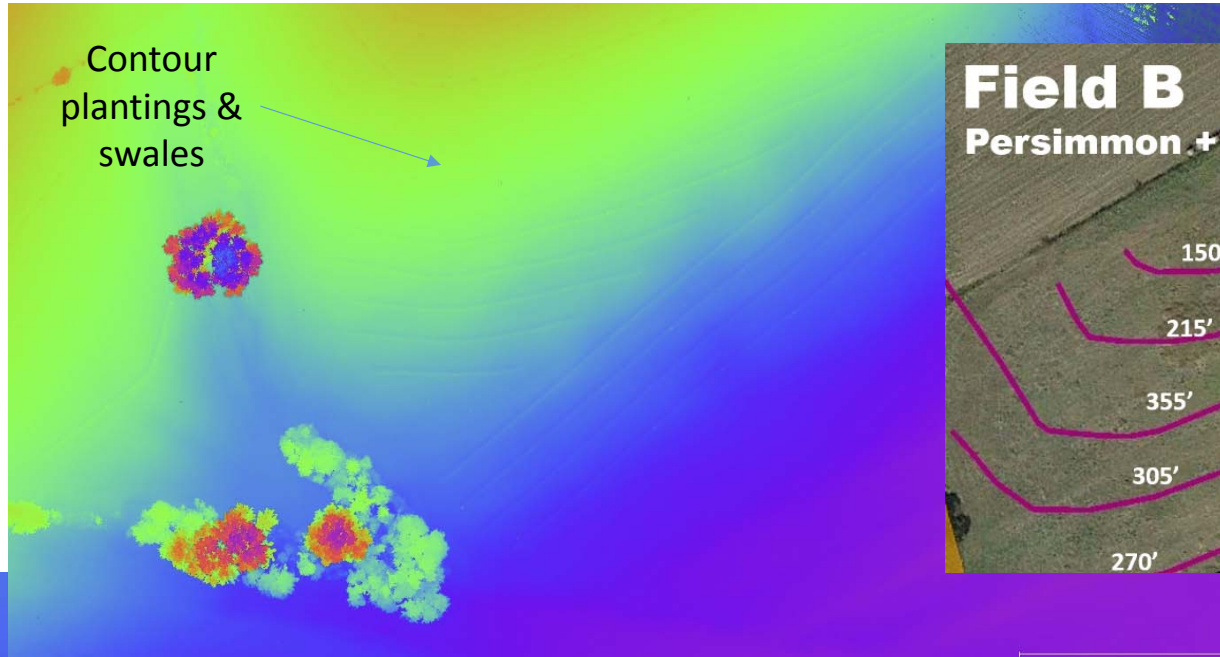
(@ Catawba Sustainability Center)

- Adam Taylor (CSC), John Munsell (FREC)
- Catawba Sustainability Center (CSC)
- Demo site
- 3 flights to evaluate change over time
- Vegetation height, biomass





CSC misc.



# 3D Visualization

- Nicholas Polys (ARC), Peter Sforza and others (CGIT)
- Vimeo movies
  - <https://vimeo.com/visionarium2018>
- Classified points
  - <https://www.projects2.cgit.vt.edu/streamlab/#>
  - <https://www.projects2.cgit.vt.edu/catawba/#>



# Thanks

