

UNMANNED AERIAL SYSTEMS MODELING IN A GEOGRAPHIC INFORMATION SYSTEM

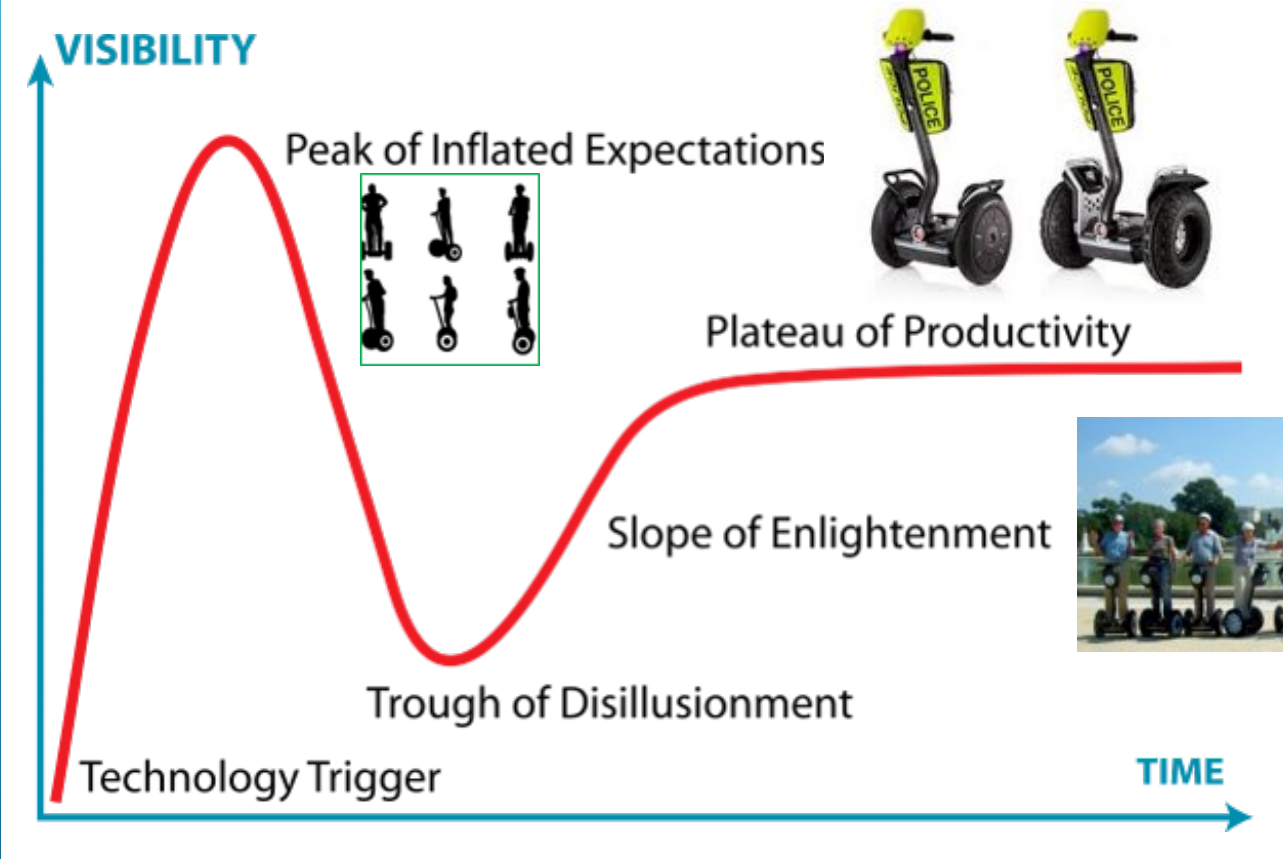
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UAS HYPE AND STATE OF UAS TECHNOLOGY



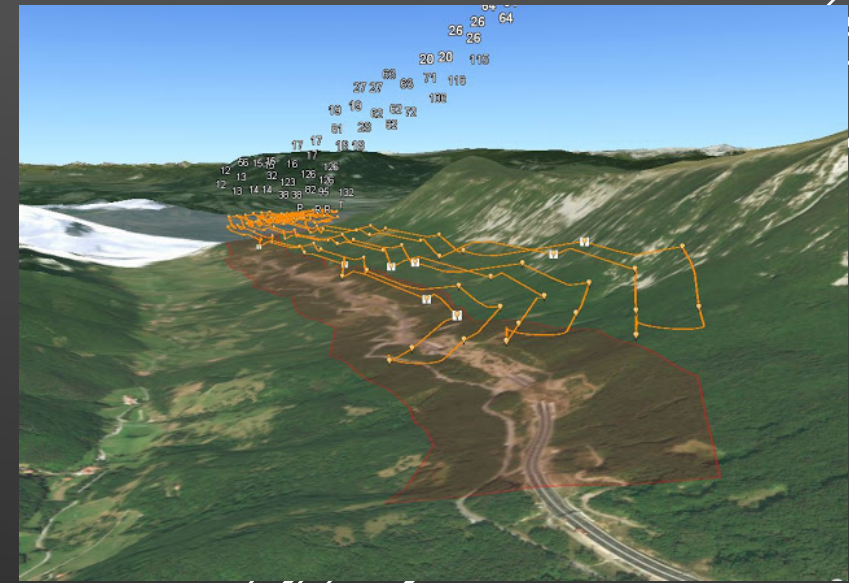
UAS AS A REMOTE SENSING TOOL

Advantages

- ▶ Rapid Deployment
- ▶ Frequent Deployment
- ▶ Nimble/Agile (Fly in tight spaces)
- ▶ High Pixel Resolution (GSD)
- ▶ High Temporal Resolution
- ▶ High Locational Accuracy (with control)
- ▶ Low Operating Cost*

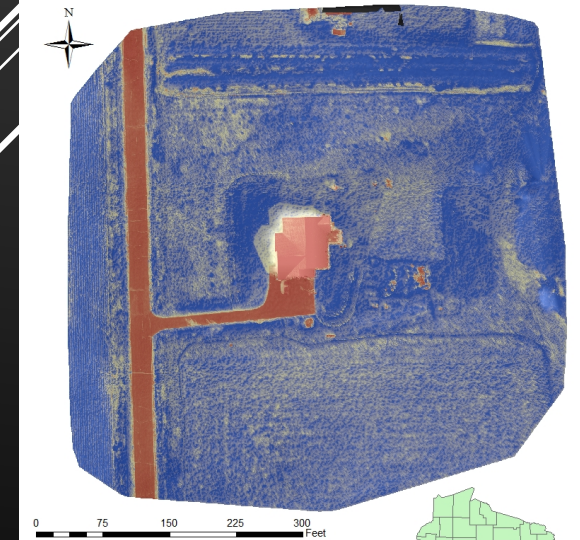
Disadvantages

- ▶ Small Coverage Area
- ▶ Weather Condition Limitations
- ▶ Altitude Restrictions
- ▶ Airspace Restrictions
- ▶ Cannot Fly over people
- ▶ Cannot Fly at night
- ▶ Data Storage
- ▶ Data Processing
- ▶ High Initial Cost*



Normalized Difference Vegetation Index

by Zach Miller

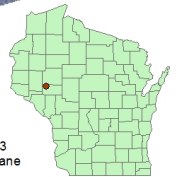


NDVI

Vegetation Health

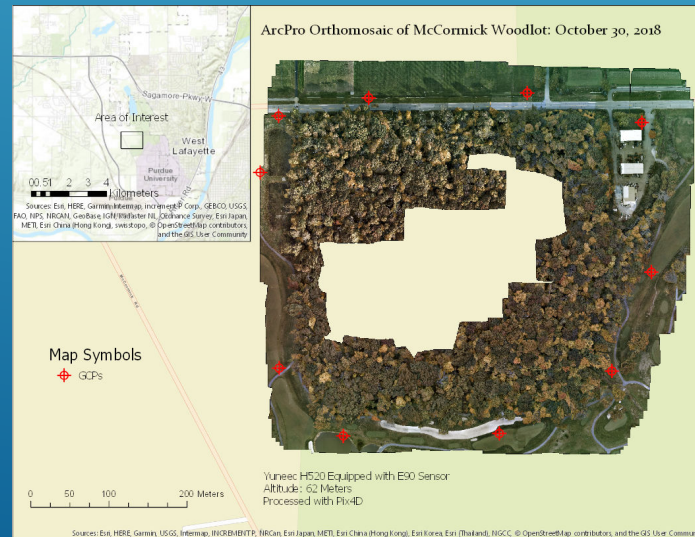


Data provided by Dr. Joe Hupy
UAV: DJI Phantom
Sensor Type: MicaSense RedEdge 3
Projection: Wisconsin Central State Plane



FACTORS TO CONSIDER WITH UAS

- ▶ For UAS to be successful, must follow three rules:
 - ▶ Low (High Resolution, no clouds)
 - ▶ Slow (Gather data in tight spaces)
 - ▶ Under Control (Must be accurate and timely)
- ▶ Requires Ground Control for accurate end products
 - ▶ Spatial resolution GSD
 - ▶ Area quantification
 - ▶ Volumetrics
 - ▶ Infrastructure
- ▶ Traditional Methods
 - ▶ Ground Control
 - ▶ Tie Ins



GEOLOCATION CORRECTION SYSTEMS

► Three types:

Physical Ground
Control Points (GCPs)



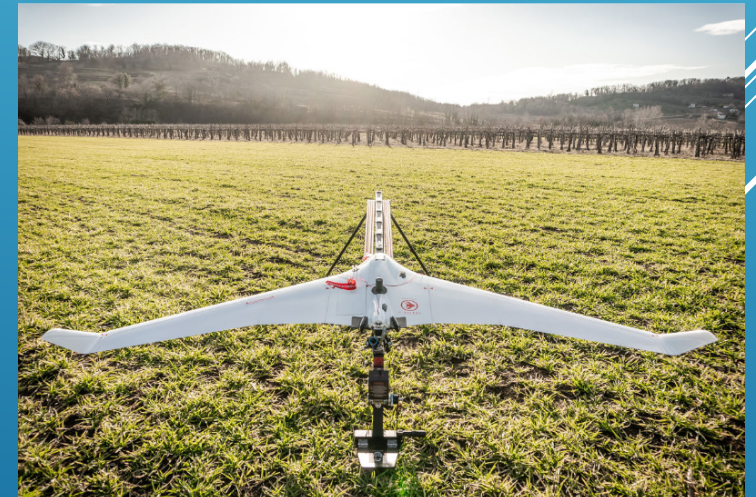
"Firmatek." *Firmatek*, 2019, firmatek.zendesk.com/hc/en-us/articles/360002710914-Firmatek-Using-AeroPoints-Guide.

Real-Time Kinematics
from GPS Base Station



"Bramor RTK." *Bramor RTK*, 2020, surveyorssource.com/bramor-rtk/.

On-board Post Processing
Kinematic GPS/Camera
Triggering System



"UAS for Mapping and 3D Modeling." *UAS for Mapping and 3D Modeling*, 2020, geo-matching.com/uas-for-mapping-and-3d-modelling/bramor-msx-uav.

TRADITIONAL GROUND CONTROL POINTS (GCP)

- What are Ground Control Points?
 - Physical markers placed throughout site
 - Coordinates collected
 - Points digitized in post processing
 - Center points ID in flight imagery
 - Improves image geolocation*
- Limitations with GCP
 - Time consuming
 - Requires open area

GCP

RTK

PPK



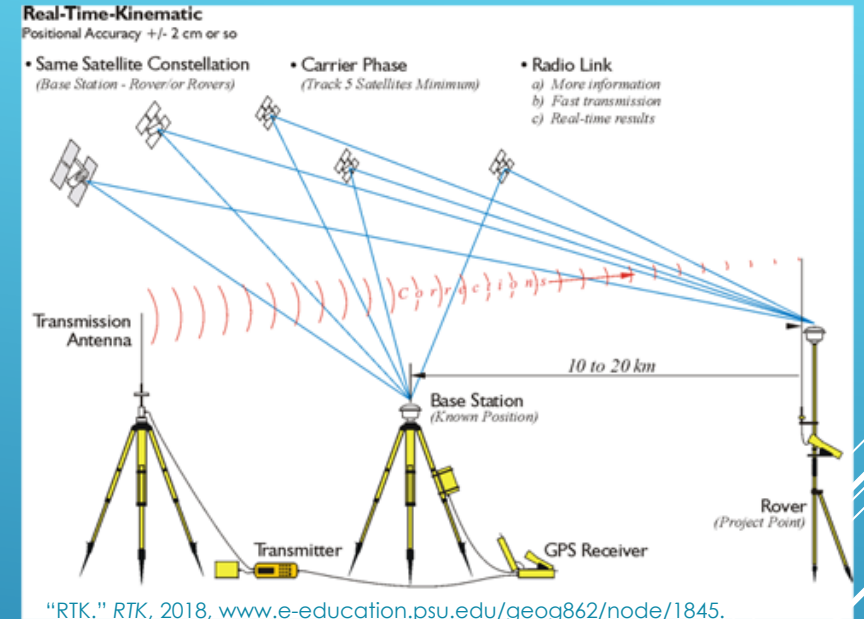
TRADITIONAL REAL TIME KINEMATICS (RTK)

- What is Real-Time Kinematics?
 - In-flight course corrections from dual frequency GPS base station
 - UAS acts as rover
 - Log file used to geolocate images
- Limitations with RTK
 - Distance between base and rover
 - Requires open area

GCP

RTK

PPK



PPK IS A GAME CHANGER WHEN ACCURACY MATTERS

- "Post-processing Kinematics"
 - Post-flight course corrections from historical reference
 - CORS or Base Station
- Traditional Ground Control negates several key UAS niches:
 - Safe Data Collection in dangerous places
 - Fast Surveying
 - Accuracy*
- Log file corrections used to geolocate images
- Image rendering and mosaicking adjusted

GCP

RTK

PPK



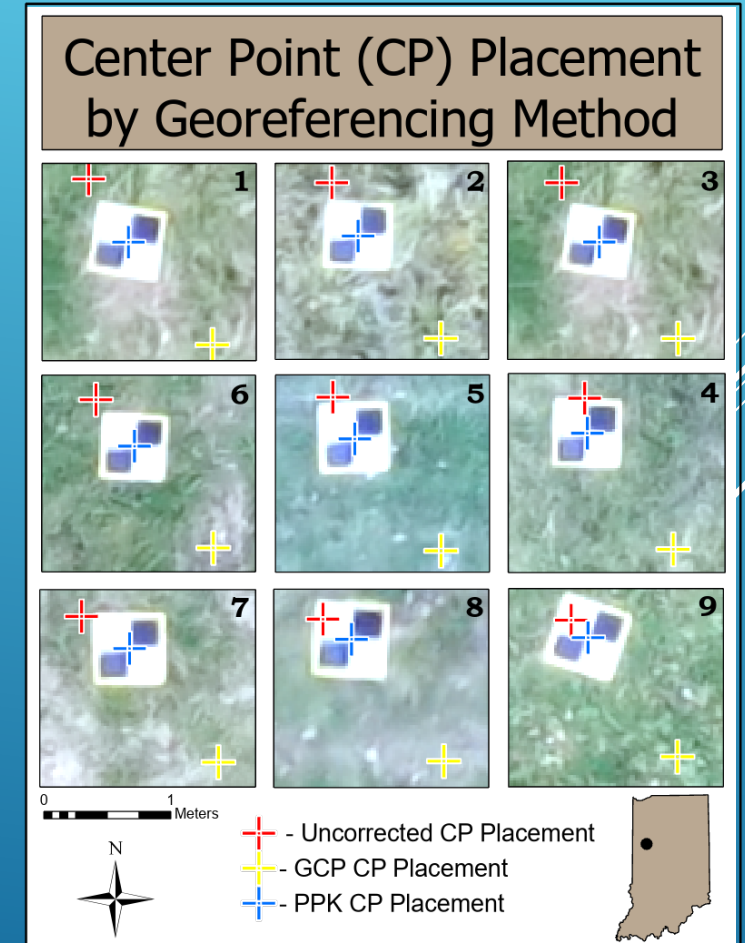
"CORS GNSS Reference Station." CORS GNSS Reference Station, 2013, emap.mesacounty.us/gps_survey/CORSMC03.htm.



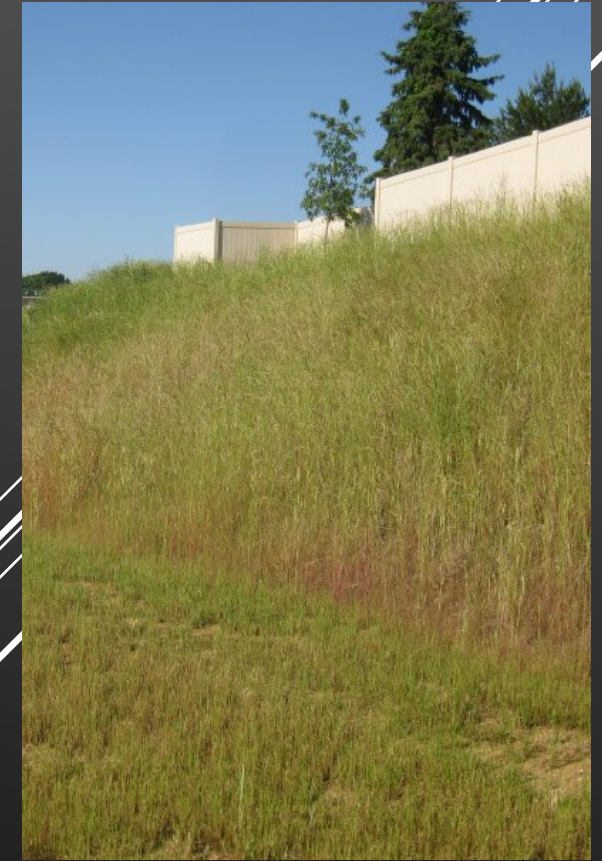
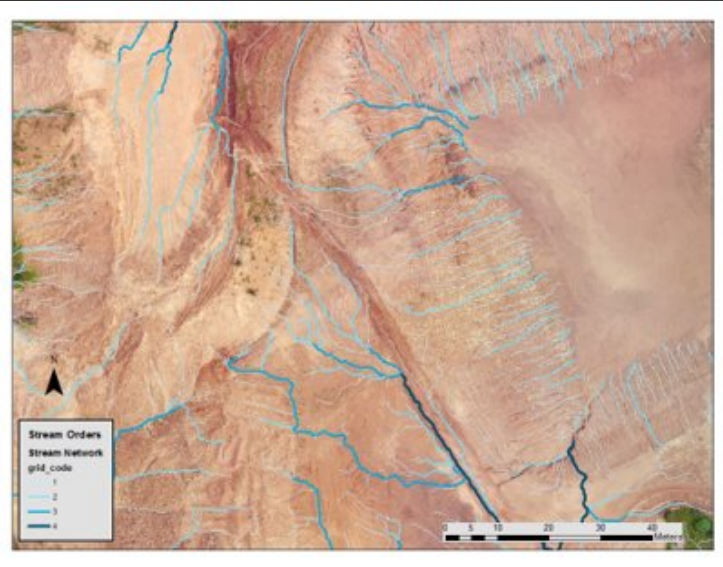
"No-Base Station PPK Direct Georeferencing for UAVs." No-Base Station PPK Direct Georeferencing for UAVs, 2020, www.uavdach.org/?p=298536.

PPK VS. TRADITIONAL GROUND CONTROL: PRELIMINARY RESULTS

Process	GCP	PPK
Place GCPs	00:10:11	-
GCP Soak*	00:45:00*	-
Collect GCPs	00:15:01	-
Upload GCPs	00:06:22	-
EZSurv Post Processing	-	00:06:02
Geotag File Editing	-	00:00:29
Mark Photos	00:10:20	-
Reoptimize	00:01:52	-
Total	01:28:46	00:06:31



MAKING USE OF ACCURATE UAS DATA



During Construction

- Utilities mapping
- 3D Site Modeling
- Vegetation stress
- Regrowth monitoring

Before Construction

- Drainage mapping
- Soil compactness
- Wildlife/Habitat
- Tree height

Post Construction

- Land reclamation
- Pavement analysis
- Vegetation Health
- Terrain modeling

CLASSIFYING LAND COVER OF A PLANNED DISTURBANCE

- Flew fixed wing UAS before and after prescribed burn

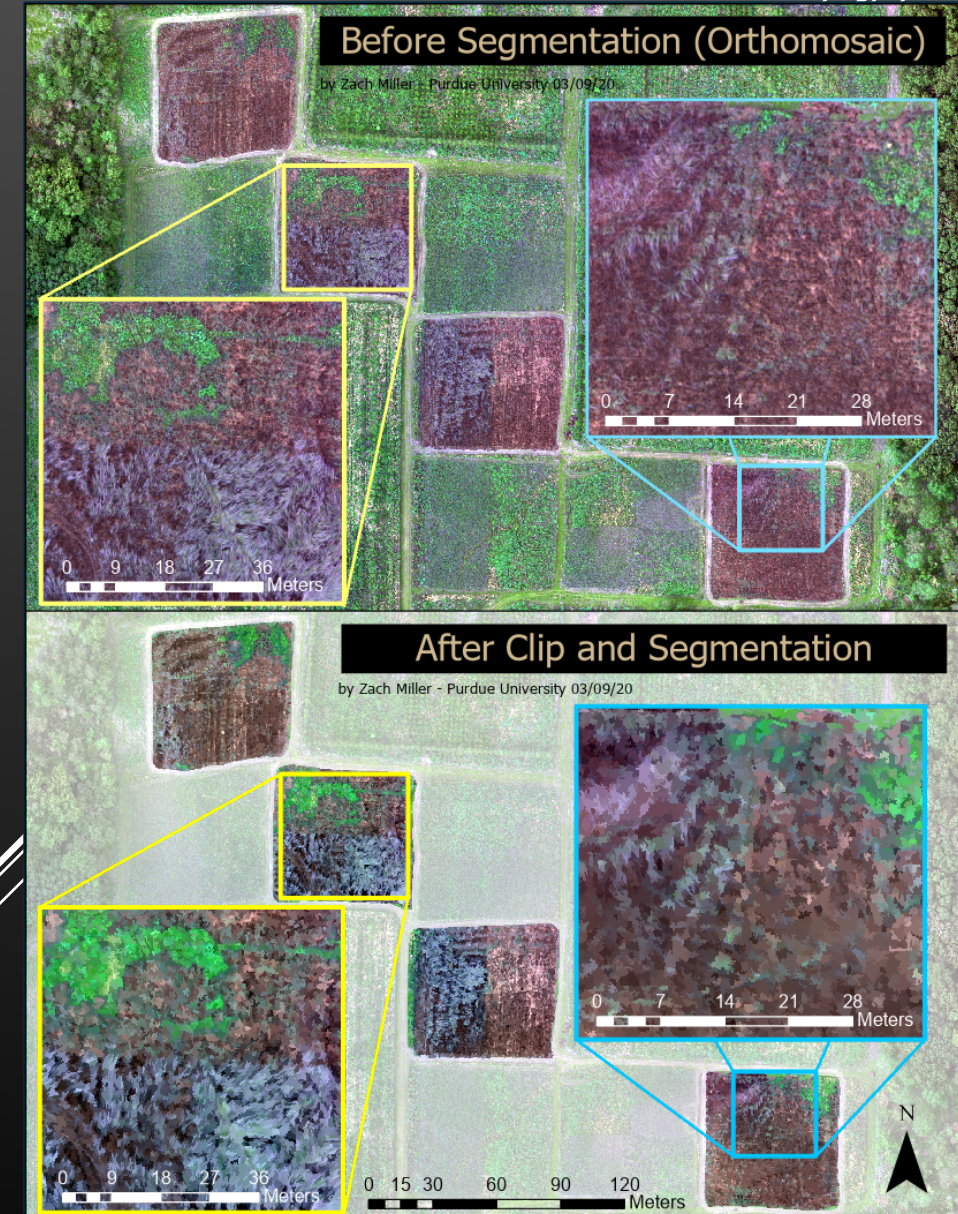
1. COLLECT HIGH RESOLUTION DATASET

- Temporal scale
 - On-demand
- Spatial scale
 - Individual Plant Level
 - 3.26 cm/pixel
- Spectral scale
 - 6-band multispectral
 - R,G,B,RE,NIR,TIR
- UAS: C-Astral Bramor



2. CLIP AND SEGMENT IMAGERY

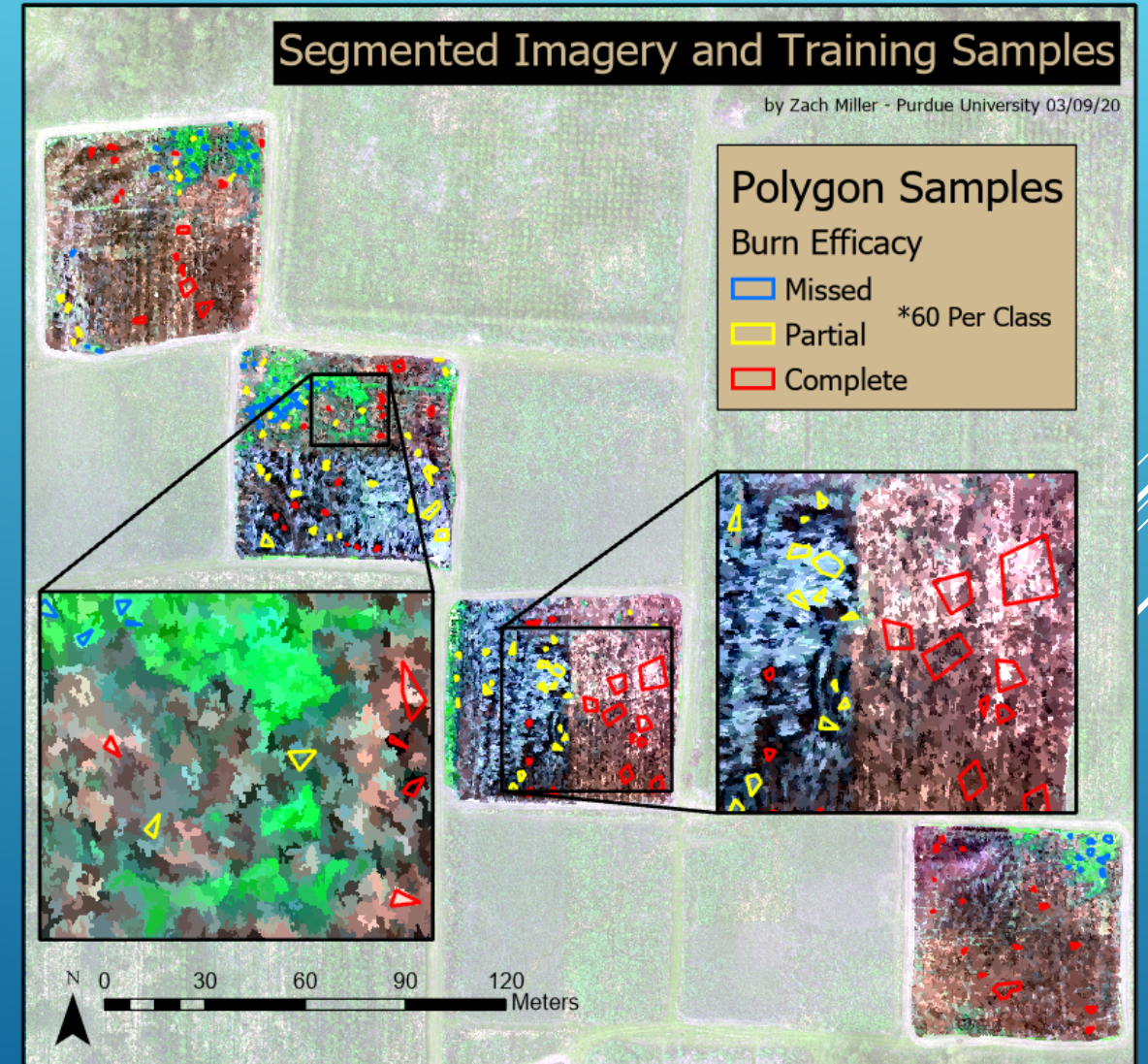
- Orthomosaic clipped to just **areas of interest**
 - Reduces unnecessary data classification
- Clipped burn plots segmented
 - Based on clustering thresholds input by user:
 - SEGMENTATION
 - Spectral: 17 pixels
 - Spatial: 10 pixels
 - Minimum segment: 80 pixels
- Segments of similar spatial and spectral characteristics



3. COLLECT SAMPLES AND TRAIN CLASSIFIER

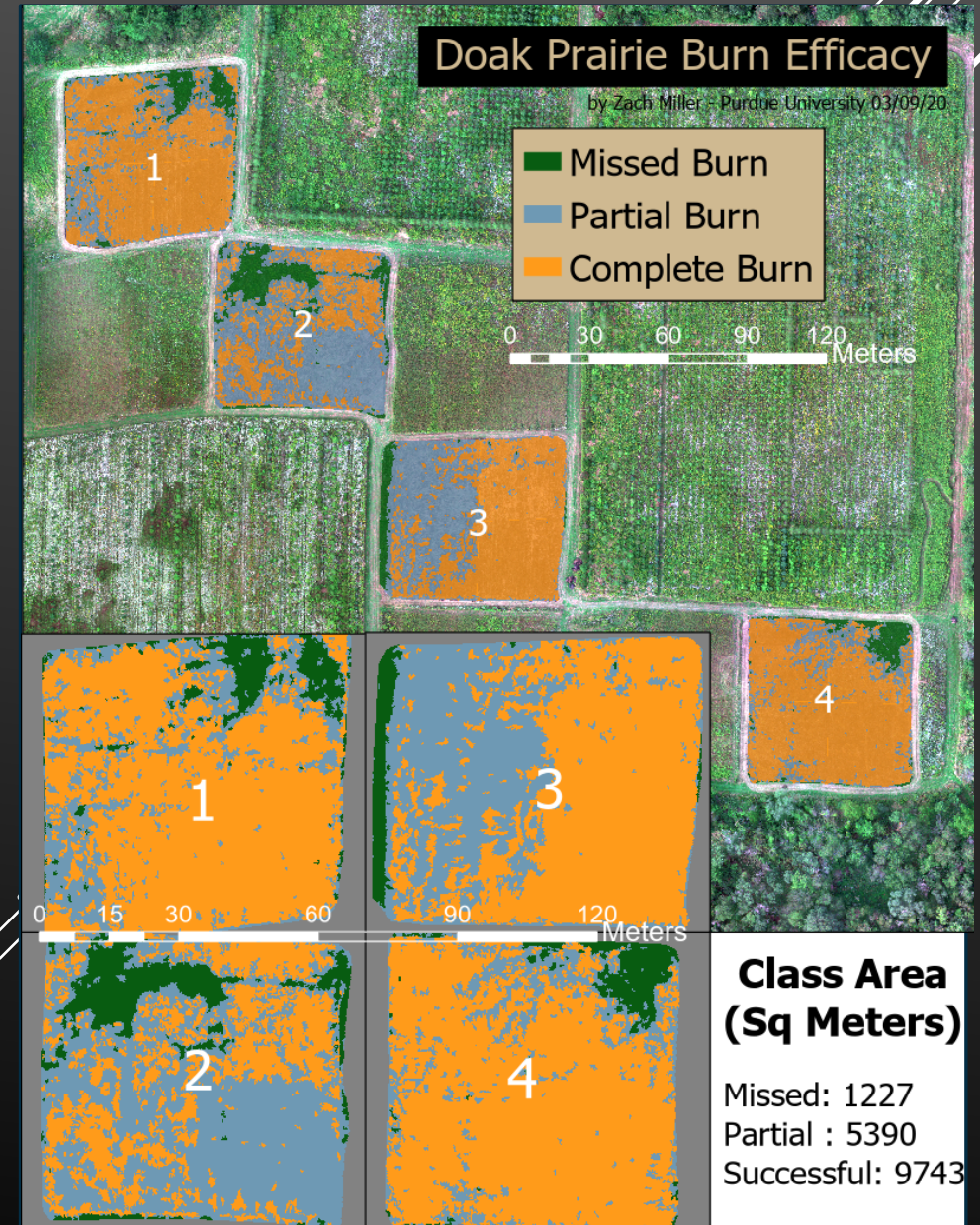
Three Burn Efficacy classes identified:

- Missed
 - Little/no discoloration
 - Little/no litter or standing veg consumed
- Partial
 - Some discoloration
 - Litter + some standing veg consumed
- Complete
 - Intense charring and discoloration
 - All litter + standing veg consumed
- 60 samples per class
- Support Vector Machine (SVM)
 - Trained with samples
 - Classifies segmented image



4. RECLASSIFY AND ASSESS ACCURACY

- Correct misclassified pixels
 - SVM ran again
- Accuracy assessment of 100 stratified random points
 - Class users and producers accuracies
 - Missed:
 - UA = 87.5% | PA = 97.2%
 - Partial:
 - UA = 88.1% | PA = 82.2 %
 - Complete:
 - UA = 95.0% | PA = 93.4%
- Overall Accuracy: 90.8%



5. AREA QUANTIFICATION AT CM-LEVEL

Calculate area covered by each class

- $GSD * Pixel\ Count$

Class	GSD (Meters)	Pixel Count	Area (Sq Meters)
Missed	0.00327	374429	1225.319
Partial	0.00327	1644441	5381.433
Complete	0.00327	2972423	9727.254

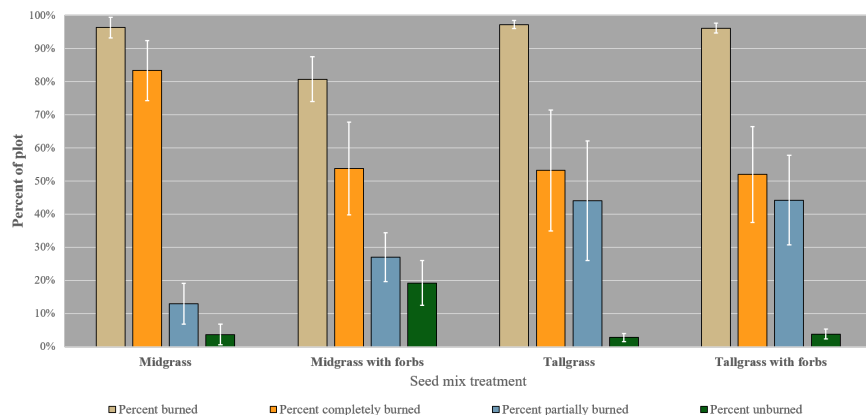
Equally effective burn across land covers

- Treatment research

WHAT TO EXPECT

- Incredible detail
 - Individual plant level of analysis
- Save time and money
 - UAS Cost Effective
 - Quick results with PPK
 - Precise treatment

Efficacy of late growing season prescribed fire
Doak Property, IN - September 2019



ROAD AND TRANSPORT APPLICATIONS

- Land Reclamation
 - Regrowth quantification
 - Soil compactness
 - Vegetation stress
- Drainage Analysis
- Erosion Modeling

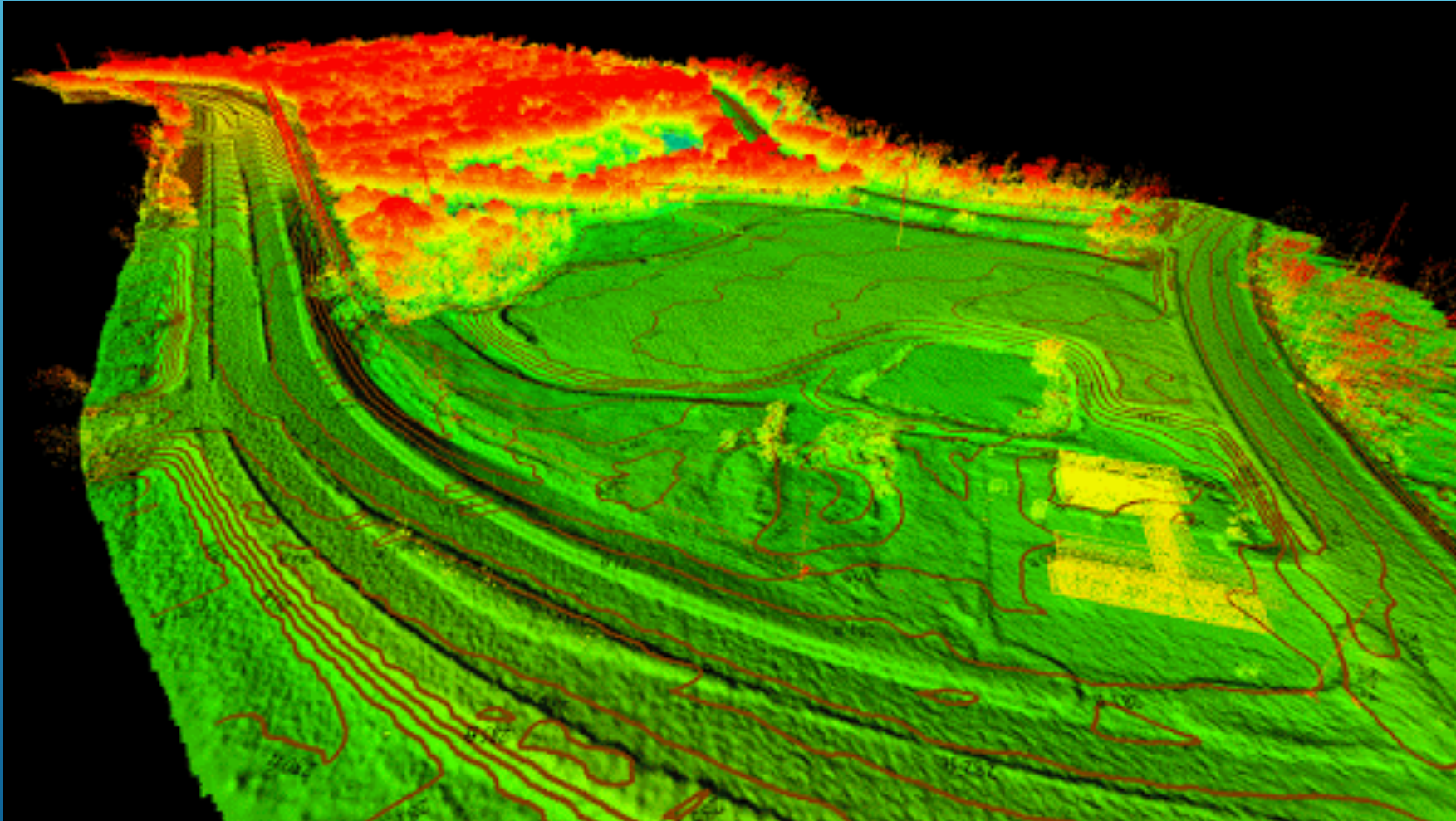


"Kitsap Daily News." *Kitsap Daily News*, 2019, www.kitsapdailynews.com/news/rules-of-the-road-for-roundabouts/.



"Trimble Civil Engineering and Construction." *Trimble Civil Engineering and Construction*, 2020, [construction.trimble.com/customer-stories/beaver-excavating-company-leverages-trimble-earthworks-20-faster-and-more-accurate](https://www.construction.trimble.com/customer-stories/beaver-excavating-company-leverages-trimble-earthworks-20-faster-and-more-accurate).

QUESTIONS?



"Drone Surveying." *Drone Surveying*, 2018, texasdroneprofessionals.com/drone-surveying/.