Characterizing Spatial & Temporal Vegetation Dynamics in Everglades STAs through a Spectrally Focused Remote Sensing Approach

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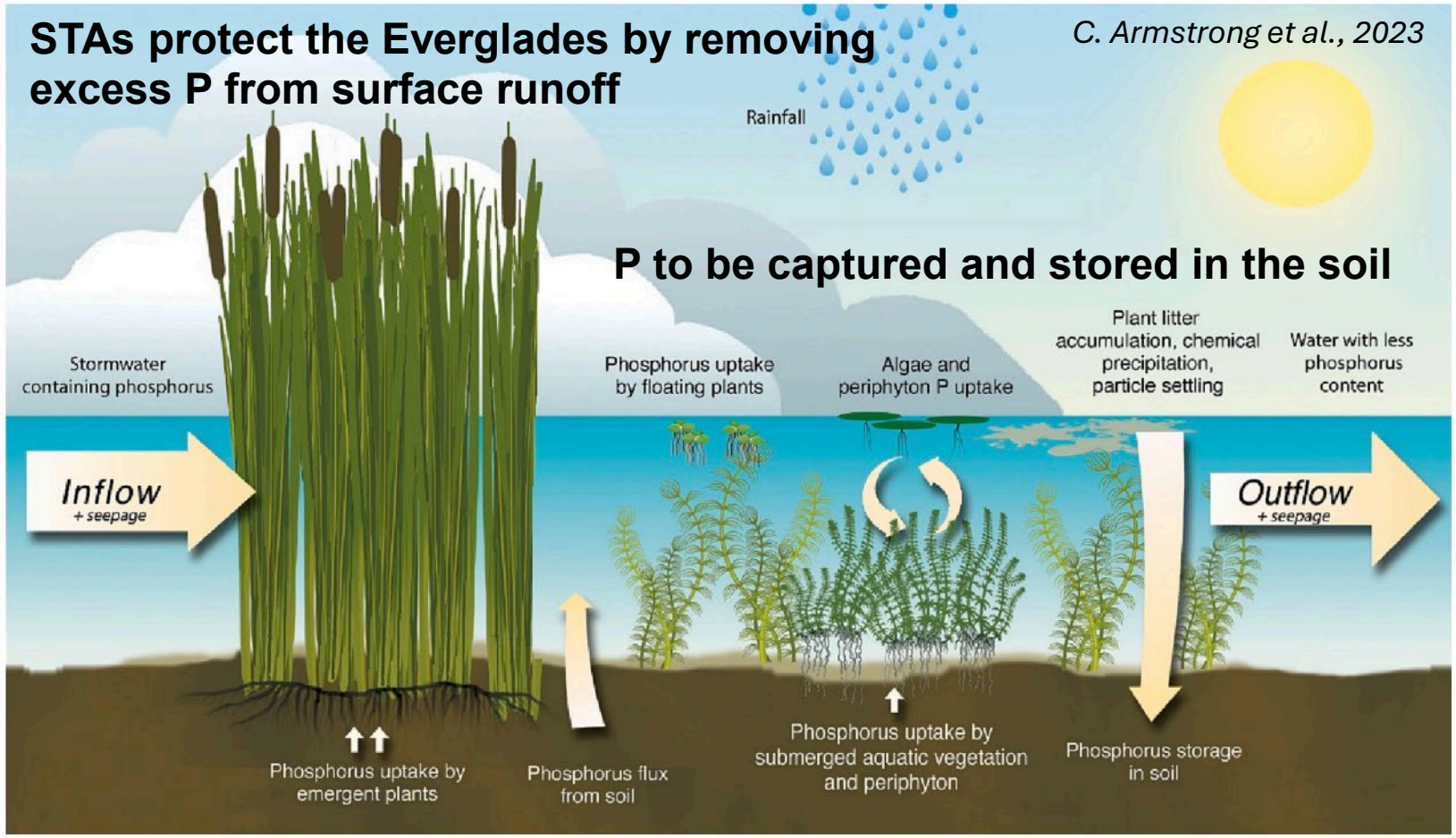
The Role of Vegetation in STA Performance

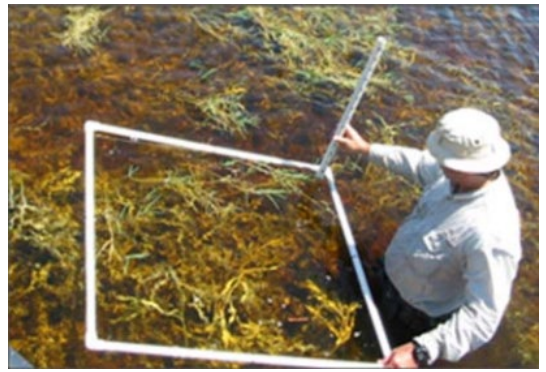


- ✓ **Vegetation is a key driver in phosphorus removal**
  - Nutrient Uptake
  - Water Flow Regulation
  - Sediment Stabilization
- ✓ **Effective STA operation depends on optimal vegetation coverage.**
- ✓ **We need to monitor and track vegetation changes over time.**

Challenges in Current Vegetation Monitoring Methods

Traditional Field Surveys

❌ Time-consuming, labor-intensive, and limited in spatial coverage



Helicopter Vegetation Surveys

❌ Subjective visual estimation, lacks quantitative accuracy.

Aerial Imagery Surveys

❌ Limited frequency, costly, and constrained by weather conditions.

These limitations make it difficult to capture vegetation changes frequently and accurately.

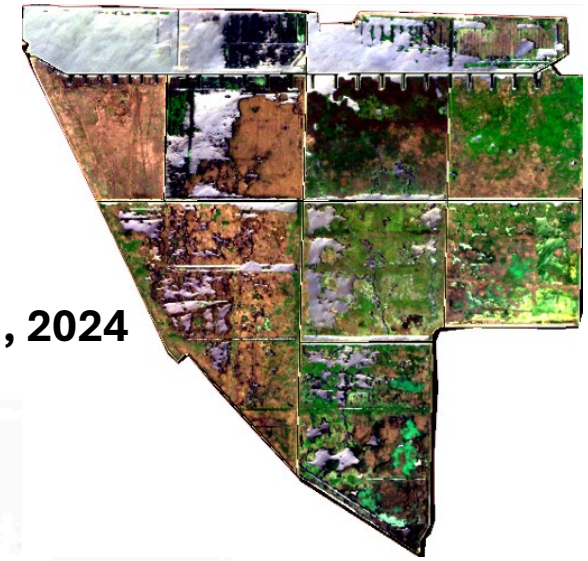
Advanced Vegetation Monitoring in STAs: Research Objectives

- ✓ **Improve Accuracy & Frequency** – Develop an advanced method for precise and timely vegetation mapping for large scale mapping.
- ✓ **Track Vegetation Dynamics** – Quantify temporal and spatial vegetation changes to analyze seasonal patterns and long-term trends, and how these shifts affect STA treatment performance.
- ✓ **Support STA Management** – Provide data-driven insights to evaluate management practices and operational strategies.

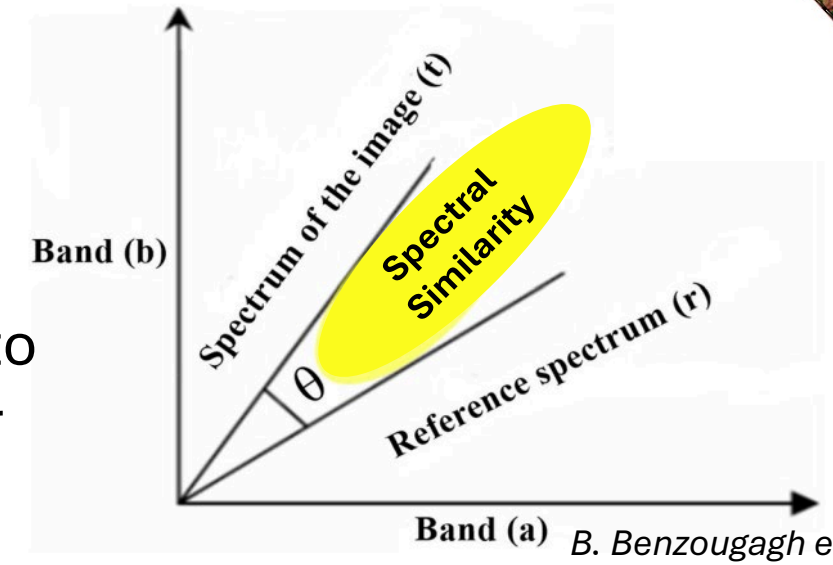
Data & Methodology Overview

- ✓ **Key Dataset:**
  PlanetScope satellite images
  - **3m** spatial resolution
  - Near-daily global imagery
  - 8-band surface reflectance data

- ✓ **Classification Methodology:**
  The Spectral Angle Mapper (**SAM**)
  - **SAM** classifies pixels by measuring spectral **similarity**, assigning them to vegetation categories based on their spectral signature.

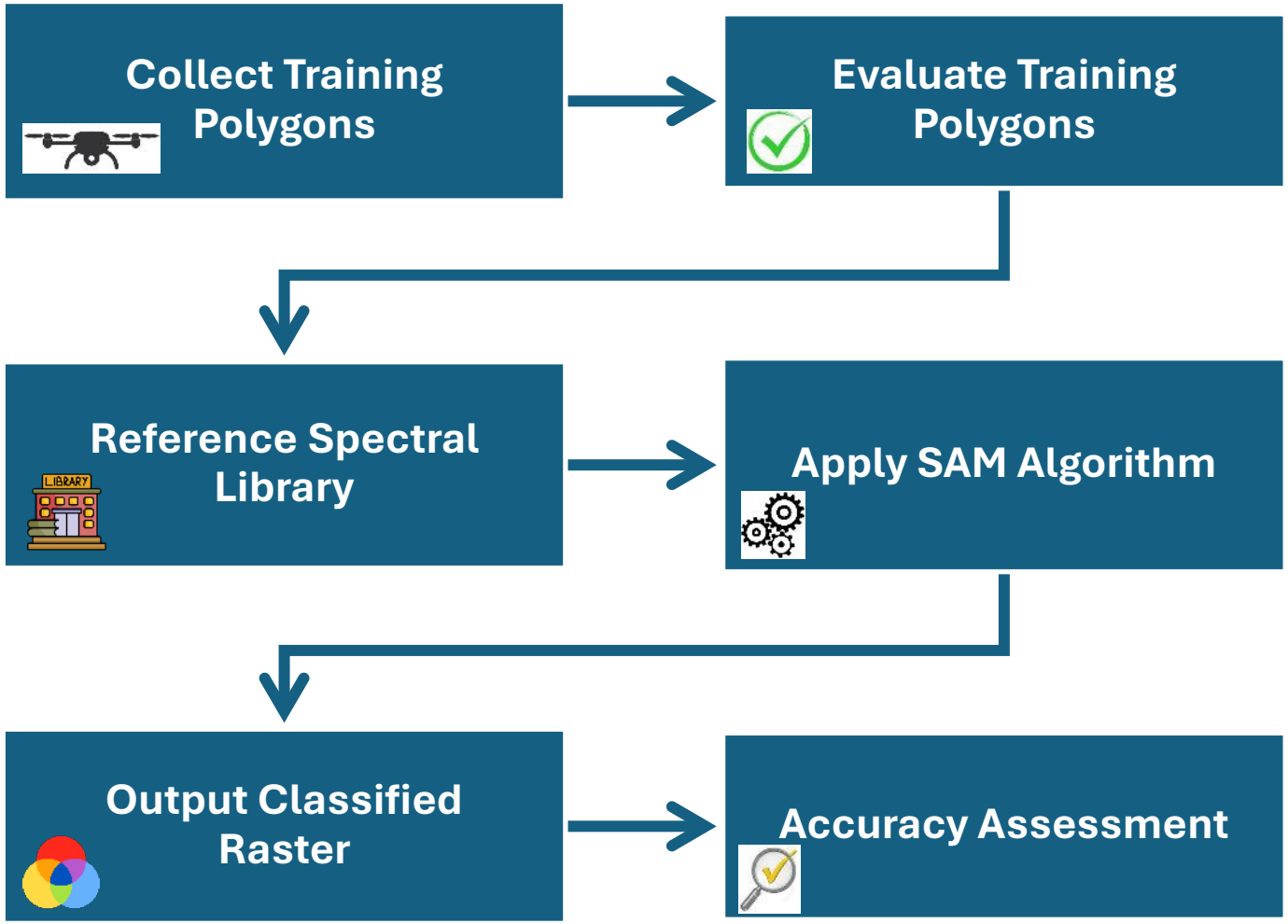


STA-1E
May 31, 2024



B. Benzougagh et al., 2023

Classification Workflow with SAM

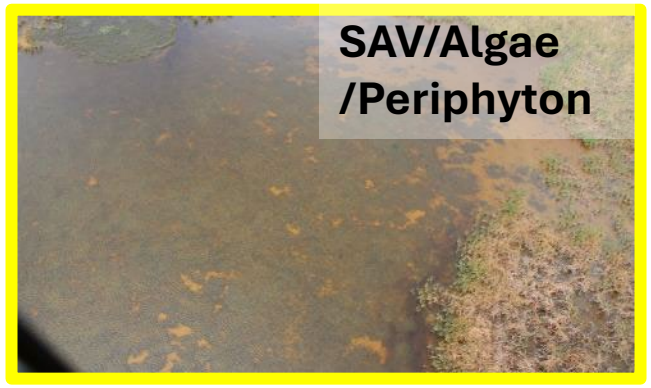


Workflow Highlights

Converting raw satellite data into a classified vegetation map using SAM.

- ✓ **Training Polygons**: 59 training polygons selected
- ✓ **Separability Test**: Index of 1.88 to 2 (strong distinction)
- ✓ **Accuracy Assessment**: 300 ground-truthing sites, with Kappa coefficient.

Vegetation Classification Categories



SAV/Algae/Periphyton
Open Water
FAV
Graminoid
Sparse Veg/Water Mix
Bare soil/ Dead Veg/Reflection
Upland Veg
Unclassified

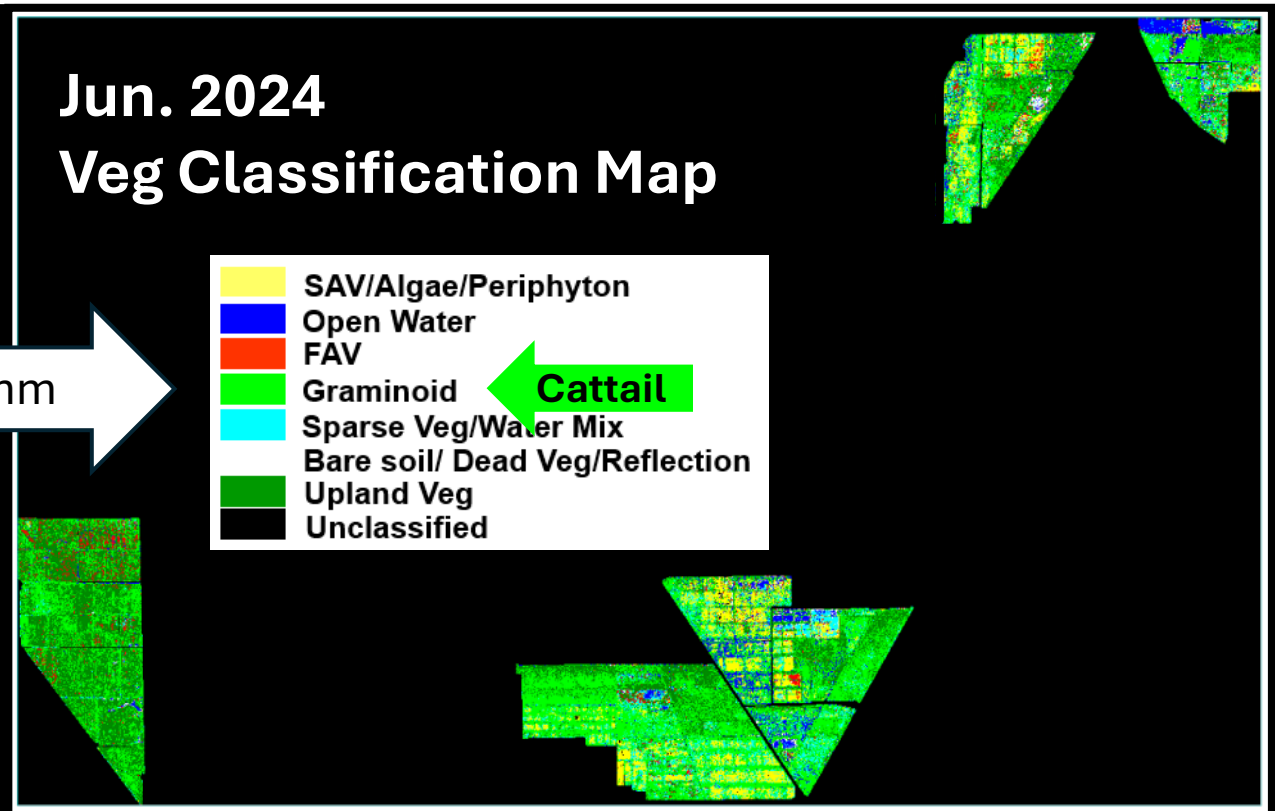
Vegetation Classification Overview

Comparison Between Raw Satellite Images and Classified Vegetation Map

May 24-Jun.4, 2024
PlanetScope Image

SAM Algorithm

Jun. 2024
Veg Classification Map



Classification Accuracy Assessment

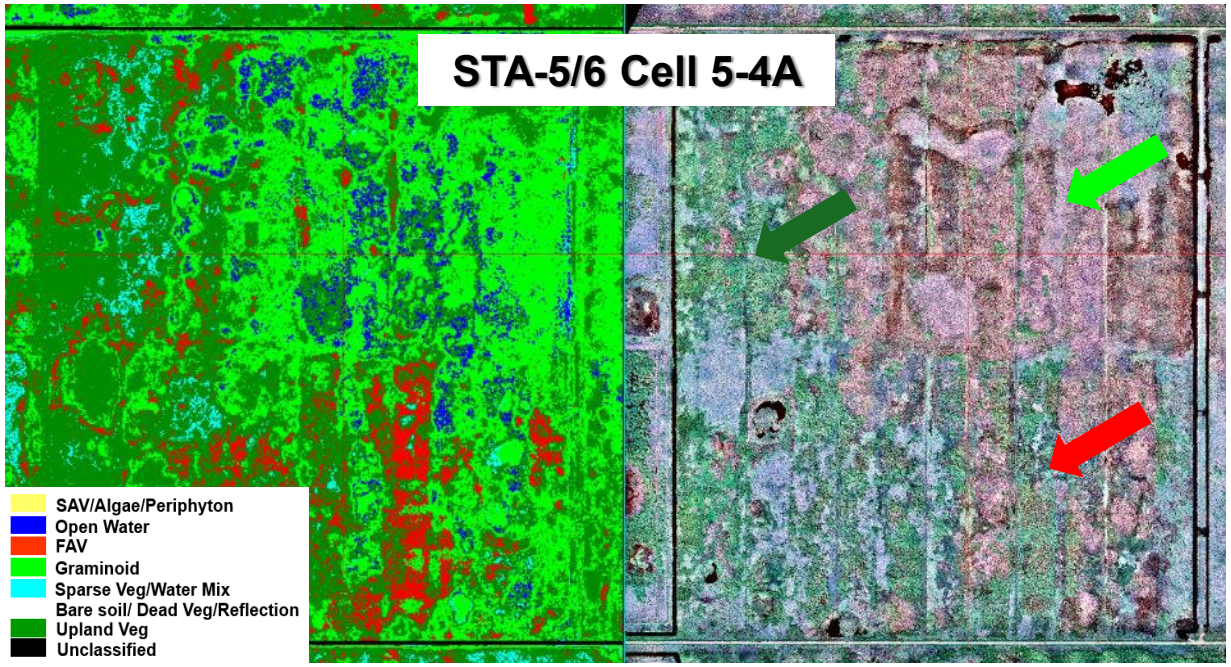
Quantitative Accuracy Assessment

Confusion Matrix:
Ground Truth vs. Classified Results

	SAV	Open Water	FAV	Graminoid	Levee/ Bare Soil	Water& Veg Mix	Upland Veg	Total (GroundTruthing)
SAV	51	3						54
Open Water		41			1		1	43
FAV	1		31				1	33
Graminoid		5	1	58			1	65
Levee/Bare Soil	1	1		1	8			11
Water&Veg Mix	1	1	2			34		38
Upland Veg			2	2			52	56
Total (Classified Map)	54	51	36	61	9	34	55	300

Total correctly classified samples: 275 out of 300
Kappa Coefficient: 90%
This indicates a strong agreement between the classification and the ground-truth data

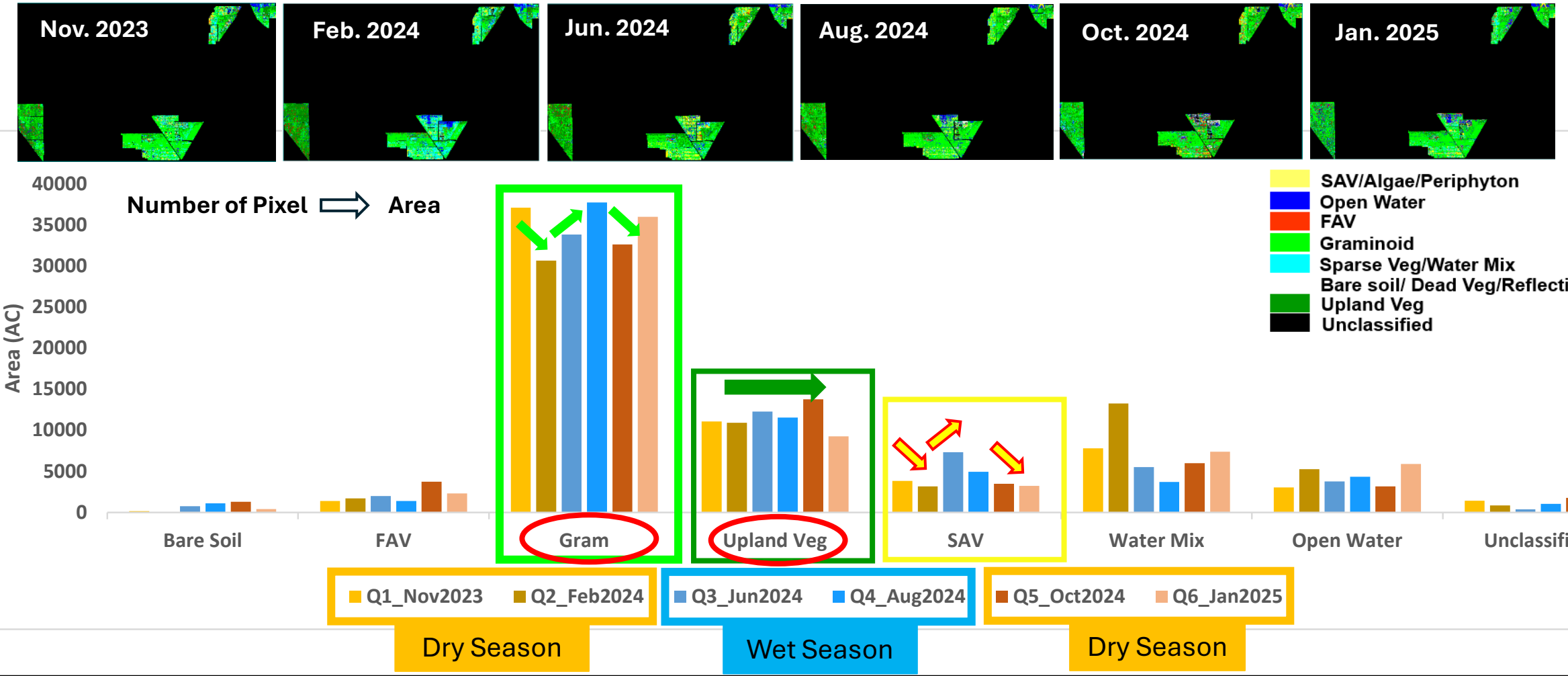
Qualitative Accuracy Assessment



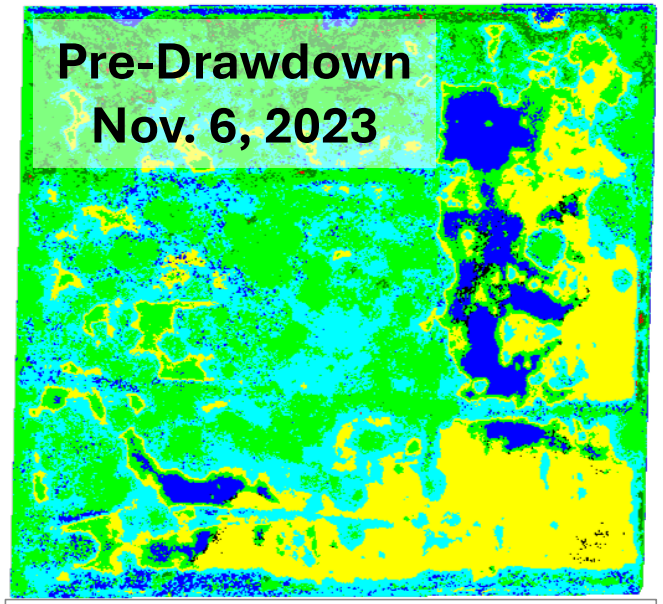
Classification Map
Feb. 25, 2024
Resolution 3 m

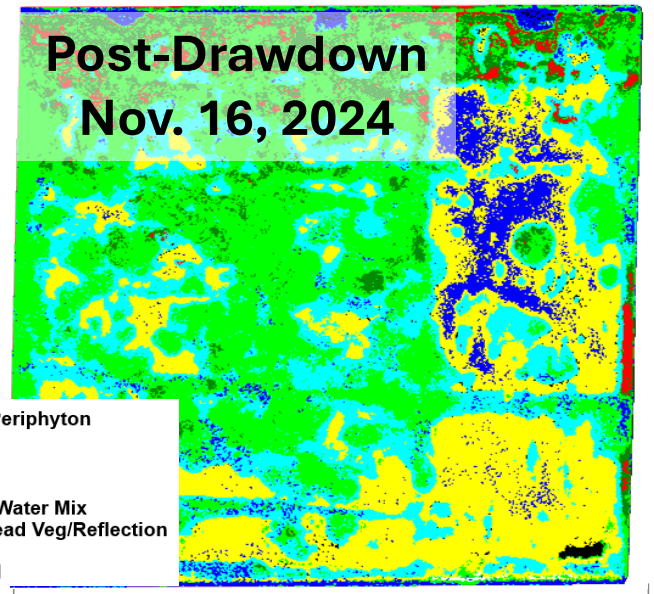
Drone Imagery
Mar. 1, 2024
Resolution 1 in

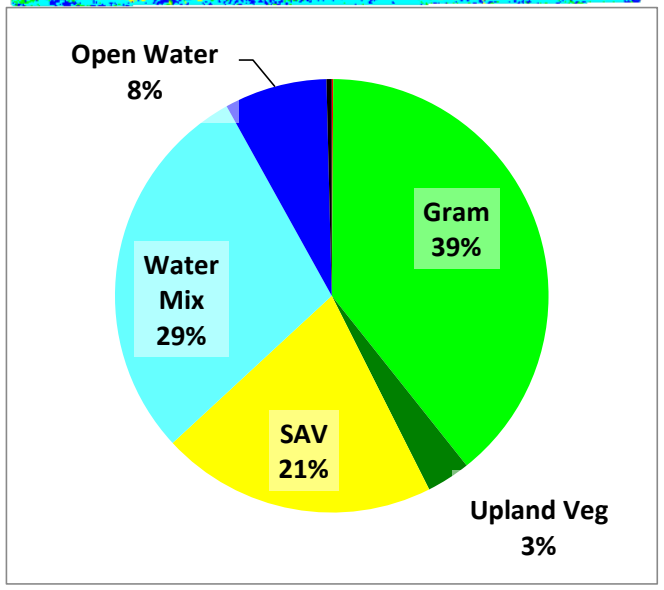
Seasonal Vegetation Dynamics to Inform STAs Management (Nov 2023 – Jan 2025)

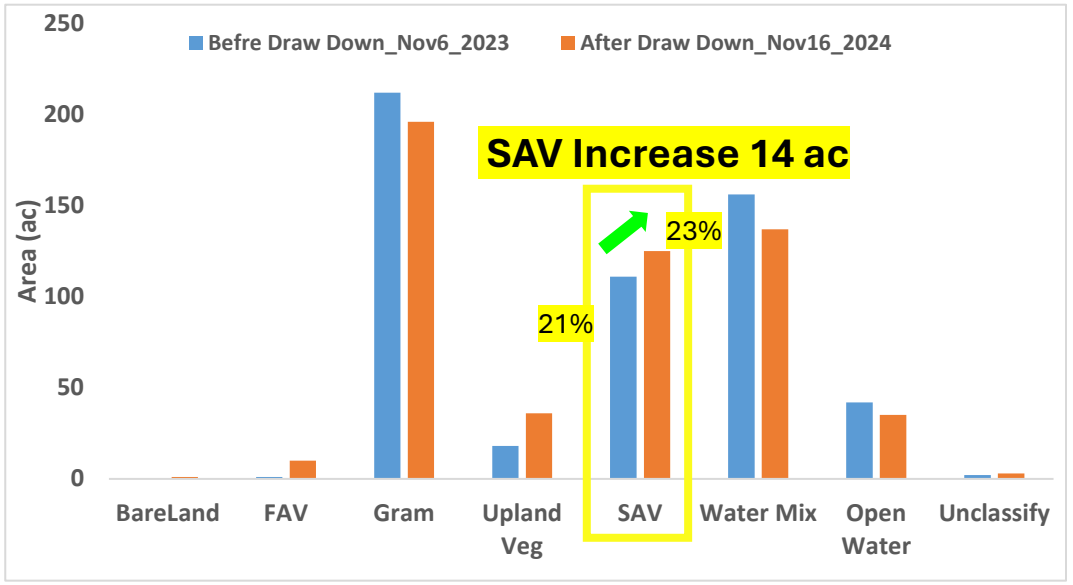


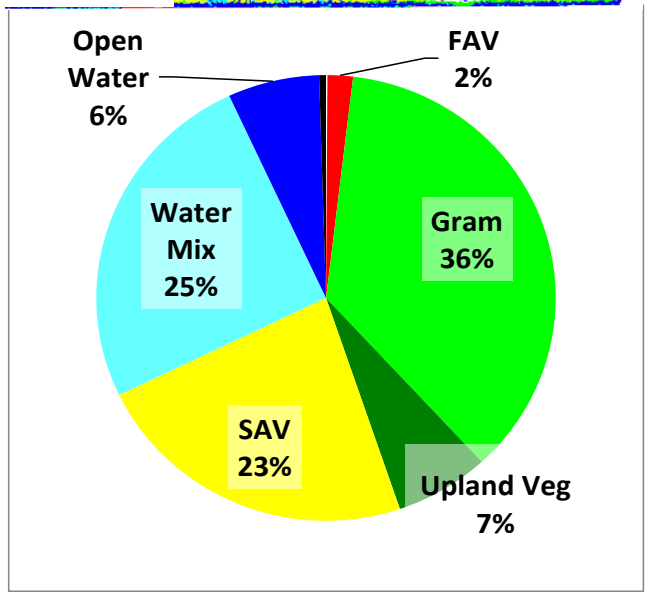
Drawdown Experiment at STA-1E Cell 2: SAV Response











Conclusion & Future Directions

Key Advantages:

- ✅ Fast and easy to apply
- ✅ Robust across seasons
- ✅ Cost-effective
- ✅ Eliminates the need for on-site interpolation

Future Improvement:

- 🛠️ Reduce misclassification
- 🛠️ Automate workflows
- 🛠️ Expand method to more projects

Acknowledgments

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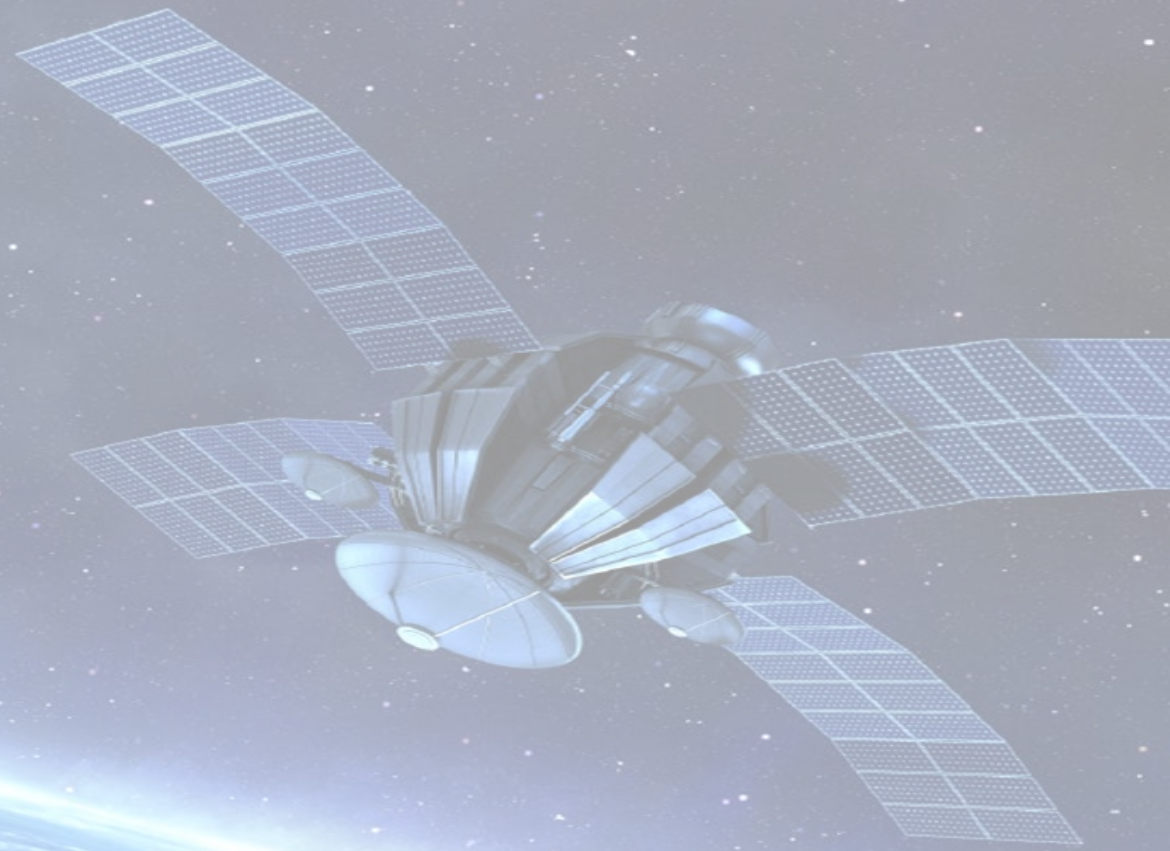

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