Using sUAS for high resolution characterization of harmful algal

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What are cyanobacteria?

- Carbon-fixing, oxygenic photosynthesizing bacteria
- Among the oldest organisms (oldest fossils c. 3.5 billion years old)
- Not always a bad thing
  - Important primary producers in aquatic ecosystems
  - Food: eg. spirulina
  - Biofuels
Biology

• Photosynthetic
  – Need light and nutrients

• Certain types can fix nitrogen
  – Symbiotic relationships with plants

• Not always a bad thing
  – Important primary producers in many aquatic ecosystems
  – Human food: eg. spirulina
  – Biofuels
Harmful algal blooms (HABs)

- HABs refer to unchecked, exponential growth
  - Toxin production
  - Oxygen depletion
- HAB risk conditions
  - Sunlight
  - High temperature
  - Nutrients
  - Slow-moving or stagnant water
  - Low competition/predation
Impacts

• Health effects
  – Animals and people
  – Need to provide alternative water

• Recreational access to affected waters may have to be restricted

• Expensive water treatment
Risk assessment

How to sample?
Where to sample?
How many samples?
Sampling frequency?

Traditional methods are inefficient
HABs are highly variable and rapidly changing in space and time.

Aug 31  Sept 14  Sept 24

A potentially lethal risk not detected by traditional sampling.

We need efficient, high resolution sampling!
Monitoring by air massively increases efficiency and resolution

500 acres/20 minutes at 6 cm resolution

Smaller areas at mm resolution
Visible and NIR reflectance

\[
\text{NDVI} = \frac{(\text{NIR} - \text{VIS})}{(\text{NIR} + \text{VIS})}
\]
Sensor options

Visible | Color-infrared | Blue NDVI
Livestock pond example

Normal image (red/green/blue)

Calibration panel
Sample marker
Cloud reflections

Note: No obvious algae gradient
      Bright cloud reflections
Microscopy

*Microcystis* spp.  
*Aphanizomenon flos-aquae*
Agisoft surface model

50 m images used for brightness value averaging (28 images)
Averaged color-infrared image (NIR/green/blue)

Blue NDVI image (NIR-blue)/(NIR+blue)

Note: Visible algae gradient
No cloud reflections

NDVI image generated in AgPixel
Buoyant packed cell volume (BPCV) expressed as a percentage of total water volume

\[ \text{BPCV} = \frac{a}{b} \]
Blue NDVI vs buoyant packed cell volume (BPCV)

Blue NDVI = (NIR-blue)(NIR+blue)

Note: Blue NDVI values were transformed to a 0-255 scale
Conclusion

• Traditional sampling:
  – High cost; long delay
  – Uncertain local risk assessment

• sUAS remote sensing:
  – Virtually complete surface sampling; efficient
  – High spatial and temporal resolution

  Ideally suited for rapid, local risk assessment
Questions?