Using small unmanned aerial systems (sUAS) for environmental mapping and monitoring

STEVEN J. STEINBERG, Ph.D., GISP

PRINCIPAL SCIENTIST, INFORMATION MANAGEMENT & ANALYSIS

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT

COSTA MESA, CALIFORNIA

Background

Field data collection is an essential component in environmental monitoring and management

- Data provide inputs to analysis and modeling

Traditionally accomplished by one of three methods

- Send a crew out into the field to collect the data
- Set out (and later retrieve) data loggers or cameras
- Contract with an aerial survey company to fly imagery

The problem

Field collection issues:

- Inaccessible sites
- Incomplete data
- Time consuming
- Expensive
- Inconsistent (especially for repeat visits)

Can Small Unmanned Aerial Systems (sUAS) help?

Provides an opportunity to capture data in new ways

- Rapid data collection
- Reduced costs and increased efficiency
- GPS control allows consistent, repeatable collection
- Complete coverage of study site (including inaccessible areas)

Better…

Faster…

Cheaper!

Approach

Obtain data at sites with relevant conditions:

- Hydromodification issues
- Varied, difficult terrain
- Multiple vegetation types/conditions

Conduct and compare multiple flights using different sensors / UAS systems

- PrecisionHawk, Orange County, SFEI

Assess resulting data to determine our ability to extract useful metrics and data

Experimental Design

Conducted flights using different sensors and systems

- Color RGB
- RGB-NIR

- Multicopter
- Fixed-wing

Evaluation of processing tools and approaches

Calibration and ground control

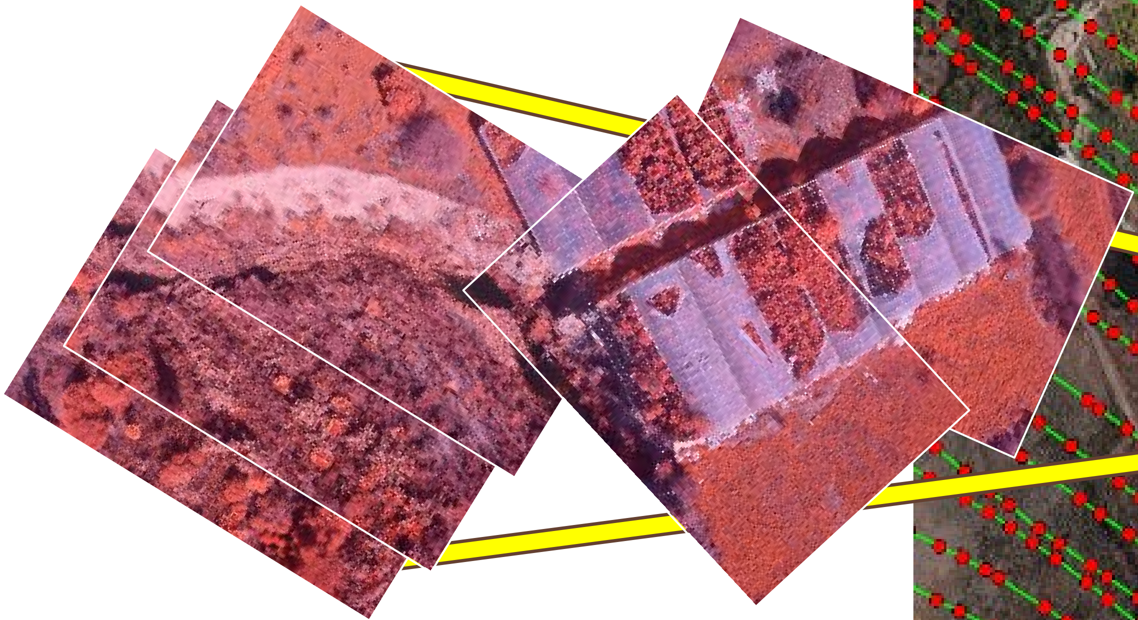
Methods

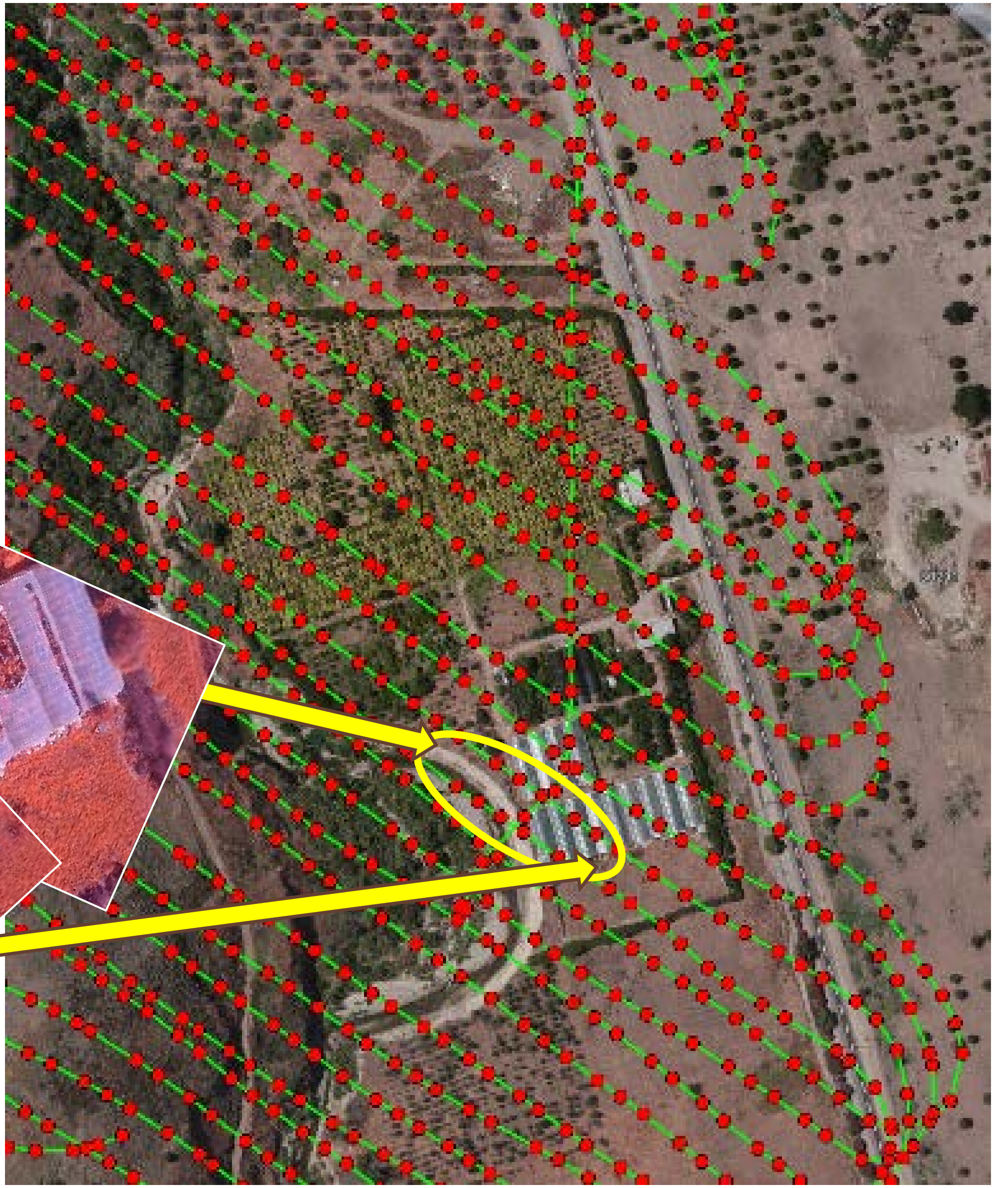
Assess data processing platforms and workflows

- High-end workstations to process large data sets
- Test capabilities of specialized software tools
  - Pix4D (industry standard)
  - Drone2Map (Esri integrated)
  - Open Source tools (R-stats)

Oso Creek

Fixed wing flight with infrared camera
(1/26/16)





Flight path with images centers

Example Results

Oso Creek

- **Measurements** of visible features
- Feature **classification** and index calculations

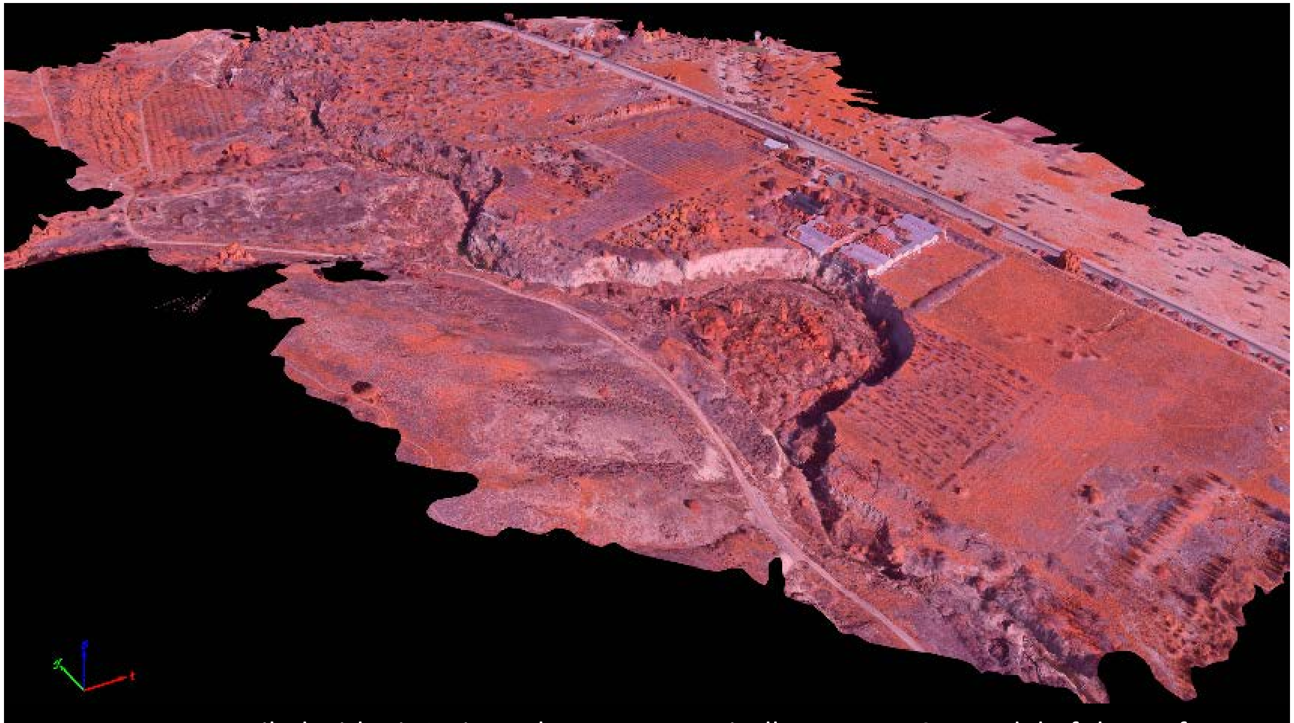
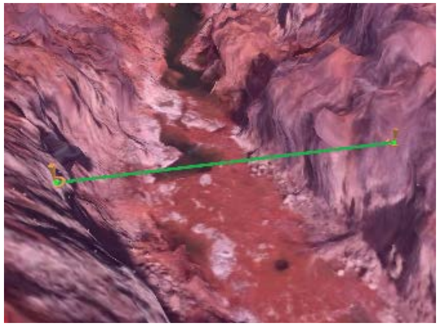
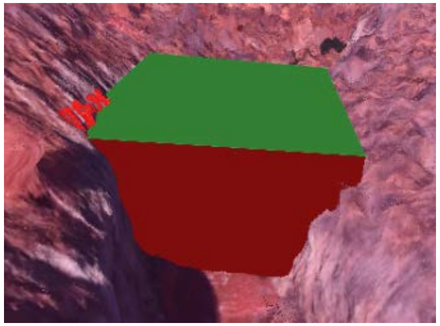


Image set compiled with Pix4D into photogrammetrically accurate 3D model of the surface.

Distances

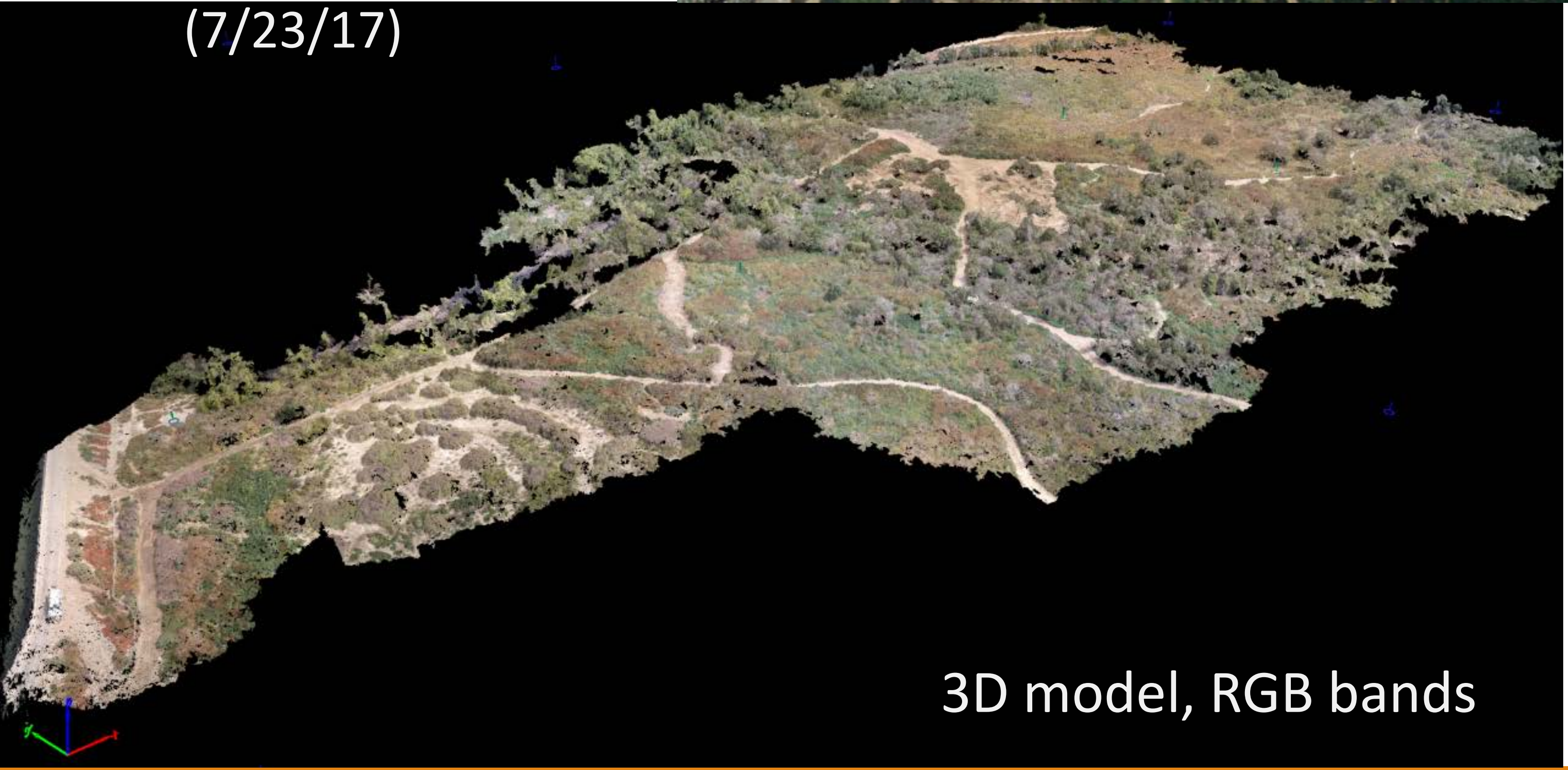


Volumes



Talbert marsh

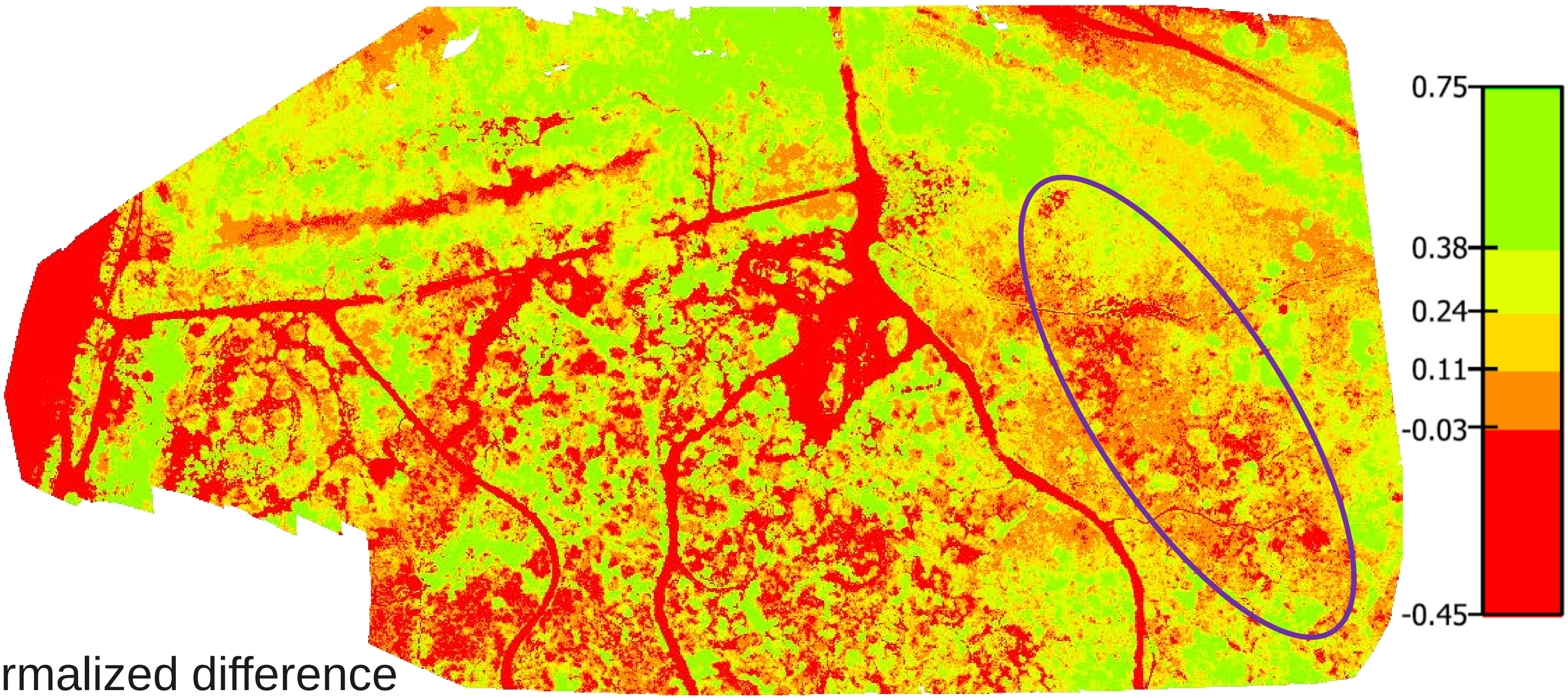
RGB and multispectral flights (7/23/17)



Band ratios

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Use NDVI to identify dead/dying willows within the marsh



Normalized difference vegetation index

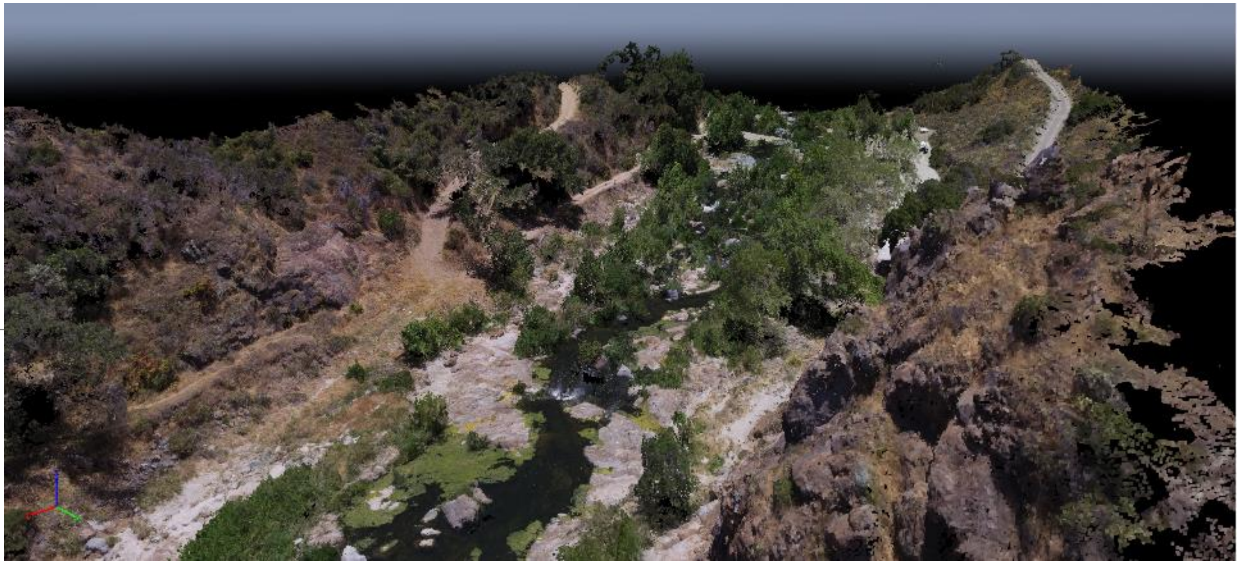
Santa Margarita River

RGB flight
(7/13/17)

Example Results

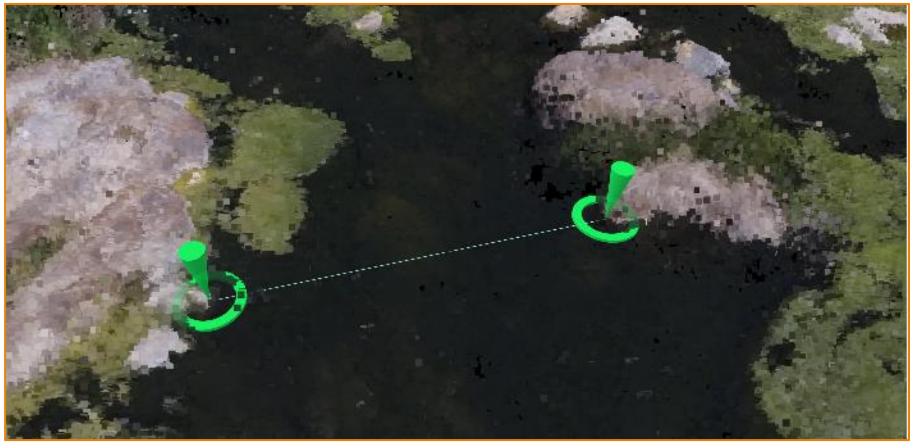
Santa Margarita River

(7/13/17)



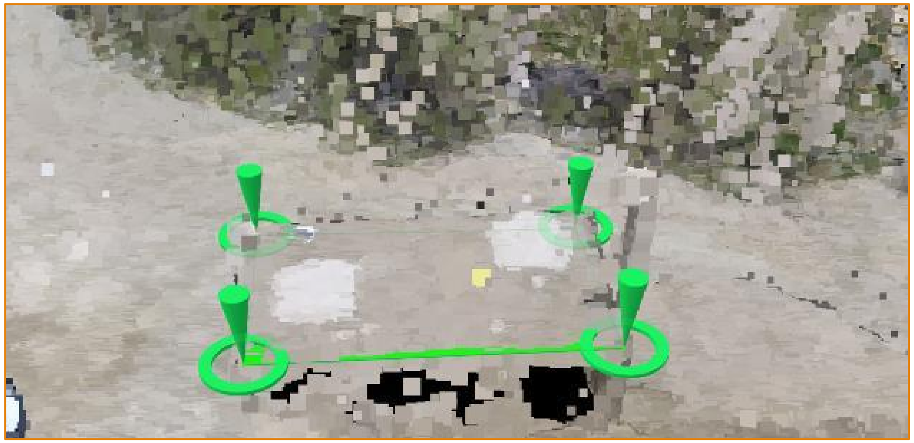
Distances

Projected 2D Length (m)	5.84 ± 0.01
Terrain 3D Length (m)	5.84 ± 0.05



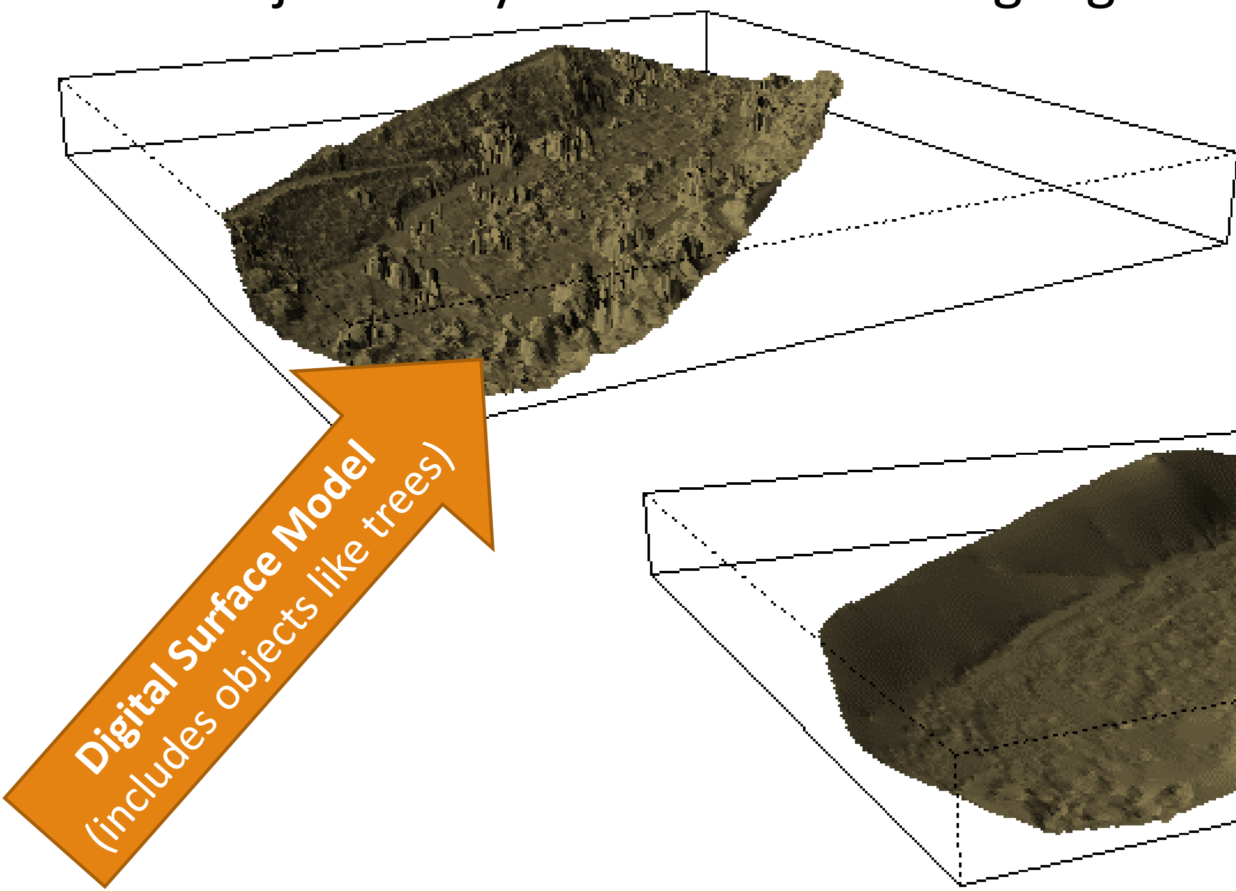
Surfaces

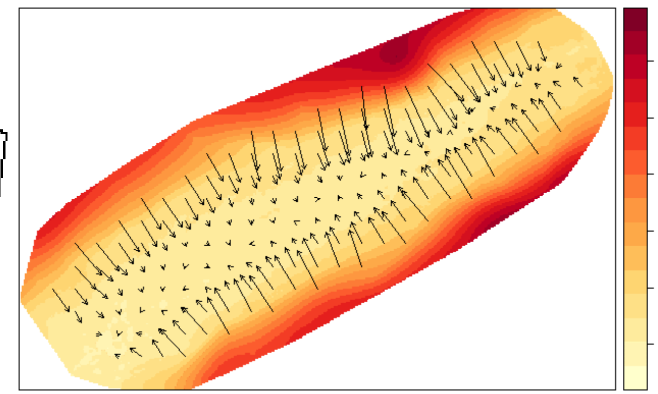
Terrain 3D Length (m)	13.72 ± 1.10
Projected 2D Length (m)	13.71 ± 0.16
Enclosed 3D Area (m^2)	11.24
Projected 2D Area (m^2)	11.21 ± 0.34

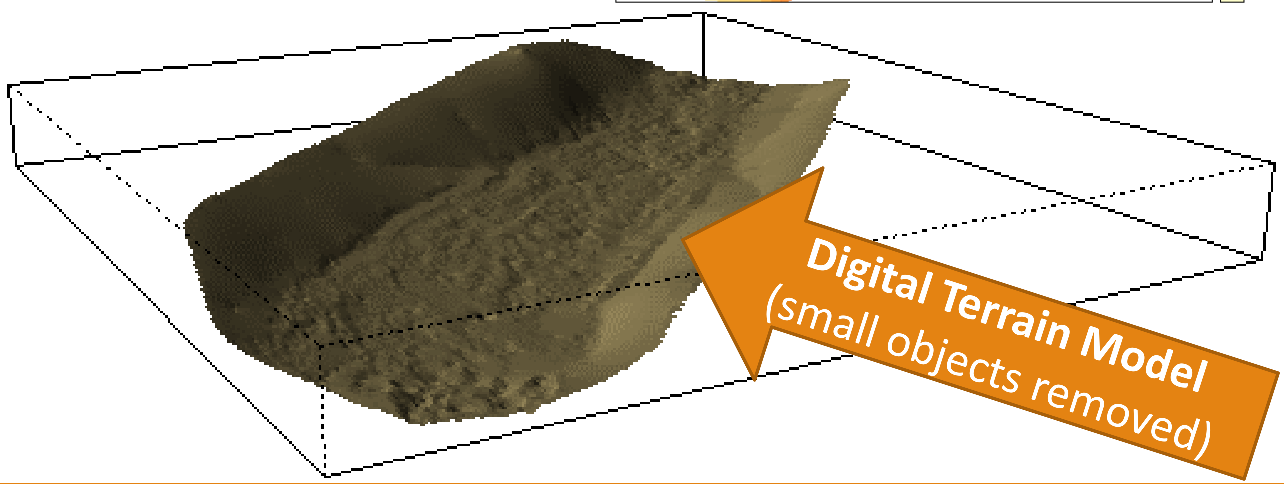


Feature extraction and terrain modeling

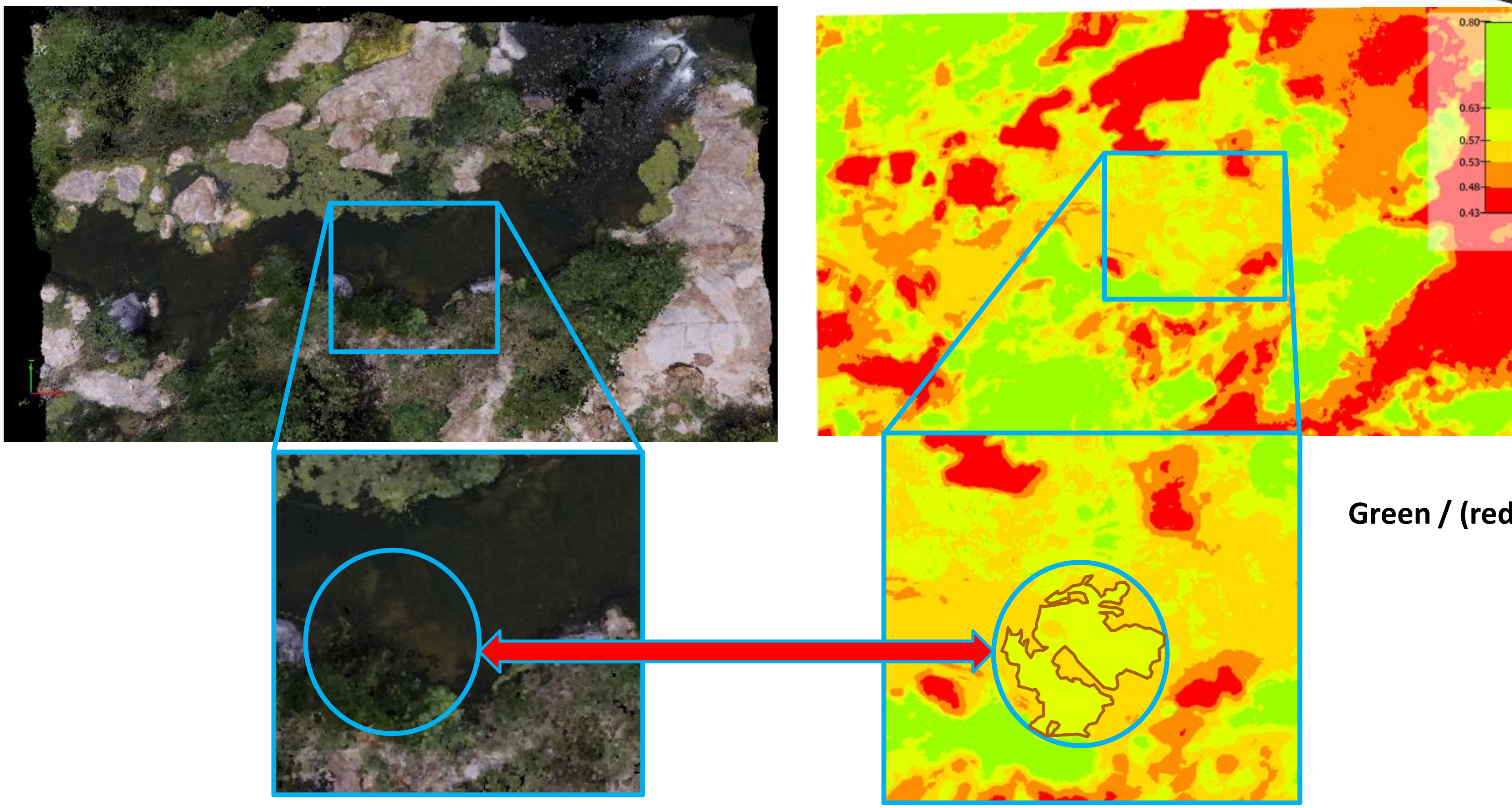
Objects may be identified to highlight **or** digitally removed







Feature Detection with Spectral Band Ratios (RGB)



Green / (red + blue)

Greenness ratio shows potential to identify underwater macroalgae

Moving forward

sUAS demonstrating potential to capture high-quality field data with multiple uses

- Accurate mapping of site condition
- Measure and map change over time
- Measurements of distance, area and volume

We'll test and validate additional applications in the next year

- Identification and quantification of:
  - Trash, HAB's, BMP's, hydromodification, vegetation and land cover, etc.

Visit me in the exhibits area!

Questions?

Acknowledgements

SCCWRP Staff:

Dr. Nikolay Nezlin: Image Analyst

Dario Diehl: SCCWRP Drone Pilot

SFEI (San Francisco Estuary Institute)

Orange County Survey

PrecisionHawk

STEVEN J. STEINBERG, Ph.D., GISP

PRINCIPAL SCIENTIST, INFORMATION MANAGEMENT & ANALYSIS

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT

COSTA MESA, CALIFORNIA

714.755.3260 • STEVES@SCCWRP.ORG

Processing time

High resolution

Processing time

Initial processing:	92 min
Point cloud and mesh:	124 min
DSM and Orthomosaic:	93 min

395 out of 402 images calibrated (98%)

Number of Matched 2D Keypoints per Image: 13325

Geolocation Error (m) (mean for 5 GCPs)

X:	-0.068050 ± 0.788119
Y:	-0.027741 ± 0.254797
Z:	-0.000004 ± 0.435837

Densified points (in m^3) 563.5

Resulting 3D models look similar

Rapid / low resolution

Processing time

Initial processing:	23 min
Point cloud and mesh:	18 min
DSM and Orthomosaic:	22 min

394 out of 402 images calibrated (98%)

Number of Matched 2D Keypoints per Image: 1229

Geolocation Error (m) (mean for 5 GCPs)

X:	-0.075496 ± 0.735453
Y:	-0.043401 ± 0.379198
Z:	0.000000 ± 0.540046

Densified points (in m^3) 95.0