



USGS – National Unmanned Aircraft Systems Project Office

uas.usgs.gov

Jeff Sloan

USGS-Geosciences & Environmental Change Science Center

National UAS Project Office

Denver, Colorado USA

October 2015



USGS UAS Implementation Timeline



- Emerging Technology Investigations.....2004-2008
- USGS UAS National Project Office Created.....May 2008
- First Systems (Raven) Acquired.....Aug. 2009
- Operator Training.....2009-2010
- Operations in the National Airspace.....March 2011
- Acquired New SystemsOctober 2015

Policies: How to Operate in the United States National Airspace

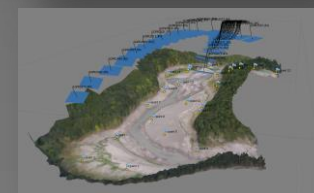
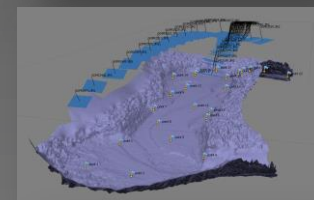
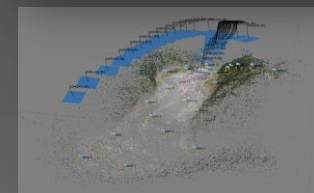
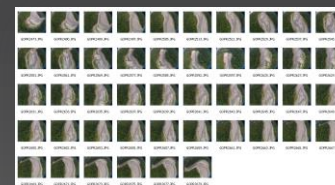
- **Certificate of Authorization (COA):**
 - Authorization issues by the Air Traffic organization to a public operator for a specific UAS activity on a case-by-case basis.
- **Memorandum of Agreement (MOA):**
 - Originally signed Dec. 24, 2013 (updated Sept. 2015) FAA and DOI
 - Information Bulletin No. 14-04
 - under 1,200'
 - line of sight
 - 5 nm from an airport (control tower)
 - 3nm from an airport (published instrument procedures)
 - 2nm from an airport (not having published instrument procedures)
 - 2nm from a heliport
 - not over people or urban settings
 - NOTAM
 - VFR weather minimums and allowed to fly at night

UAS Key Parts

UAS

Sensor

Software



Past U.S. Dept. of the Interior UAS Platforms

AeroVironment – Raven RQ-11 A



MLB SuperBat



Honeywell – T-Hawk RQ-16



New U.S. Dept. of the Interior UAS Platforms

Falcon UAS



Falcon Hover



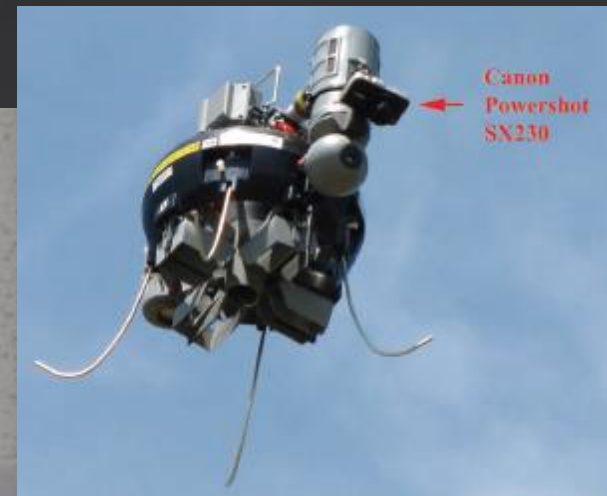
Pulse Vapor



Cameras/Sensors

Existing Sensors:

- Natural Color Video
- Thermal IR Video



Current Enhancements:

- GoPro Hero 3 & 4 - 1080P & 4K HD camera (still frame and video)
- Sony ActionCam – GPS enabled
- Canon SX260HS & S100 – GPS enabled (RGB and IR) – CHDK
- Ricoh GR – no GPS – (need ground control)



New Sensors

Calibrated Thermal Sensor



Courtesy of FLIR Tau 2 Sample Images

5-Channel Multispectral Sensor



Blue
(480 nm)



Green
(560 nm)



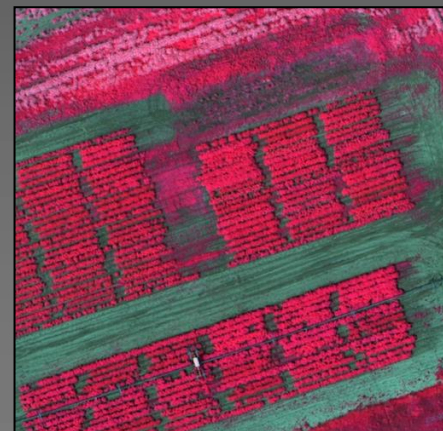
Red
(670 nm)



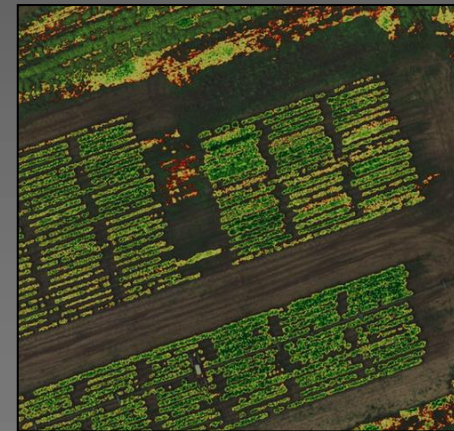
Red Edge
(720 nm)



Near IR
(840 nm)



5-Band MultiSpectral



NDVI

Courtesy of MicaSense Sample Images

New Sensors

- CO2 Sensors
- Geomagnetometers
- Hyperspectral Sensors
- Natural Color Higher Resolution
- Telemetry



DSLR



Magnetometers



LiDAR Sensor

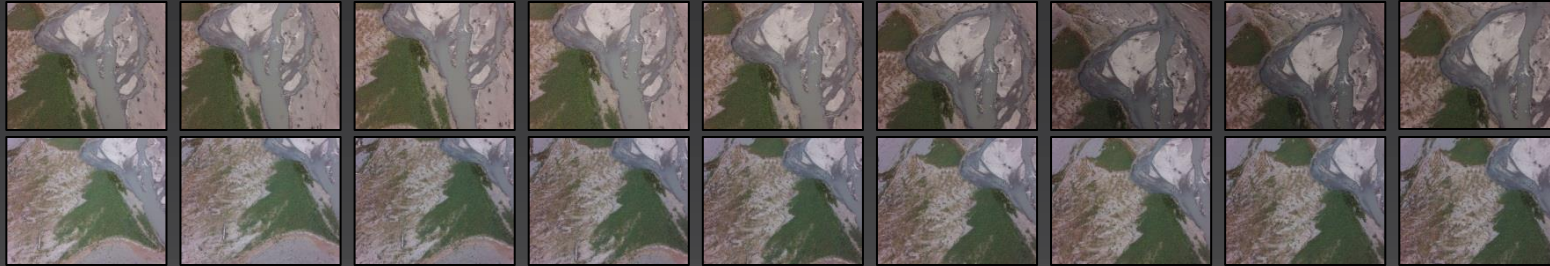


Hyperspectral
Sensor

Geospatial Product Creation

WITH DATA ACQUIRED FROM UAS

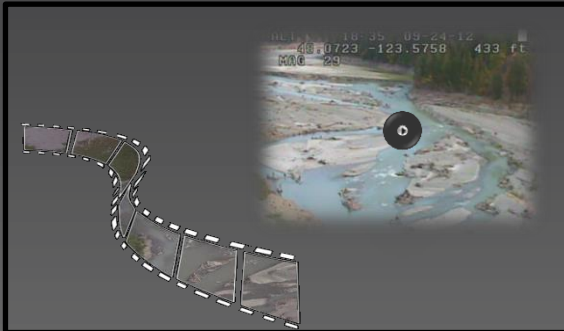
Computer Vision – Structure From Motion



STILL FRAME IMAGES CAPTURED ON-BOARD THE UNMANNED AIRCRAFT



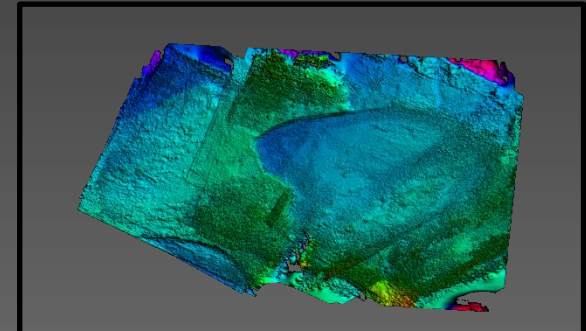
GoPro Hero2 – 11 megapixel (compressed)



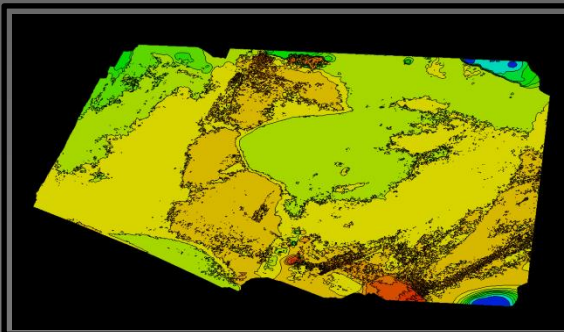
FULL-MOTION VIDEO



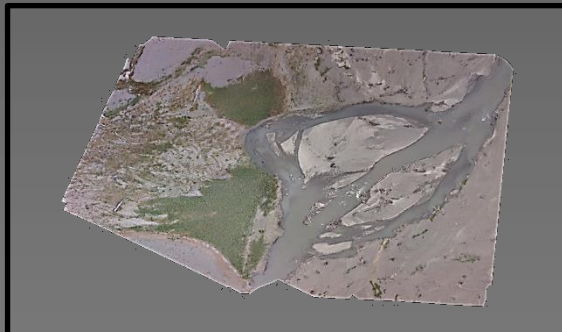
3-D POINT CLOUD DATA



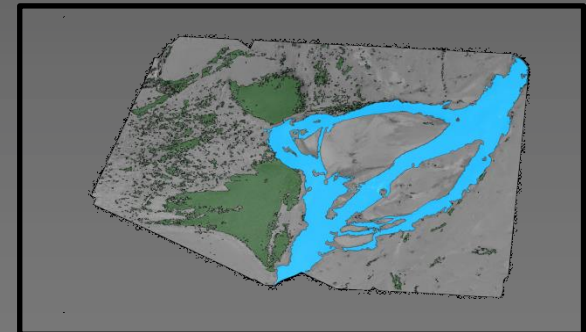
ELEVATION MODELS



ELEVATION CONTOURS



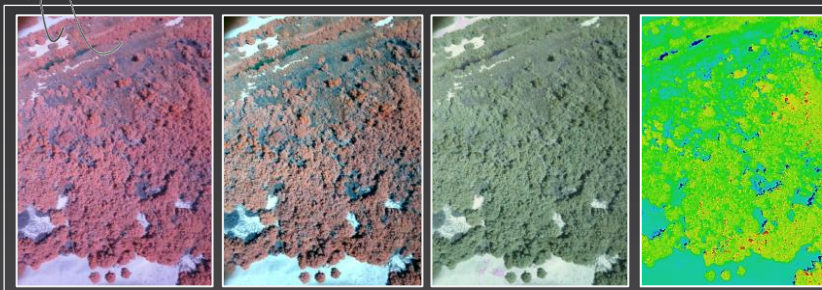
ORTHOIMAGERY



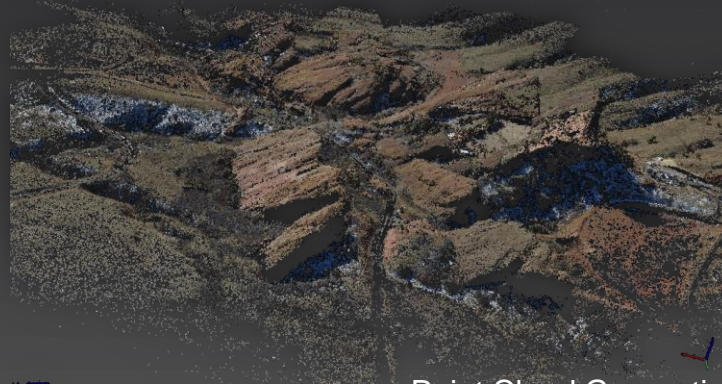
SEGMENTATION AND CLASSIFICATION



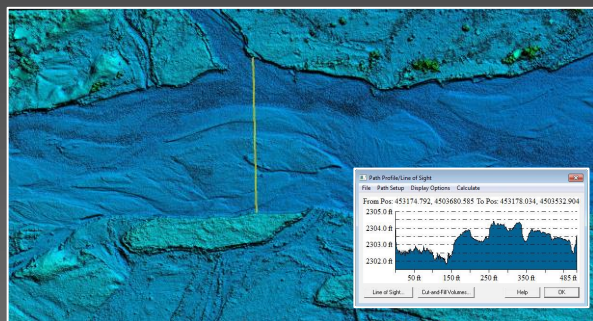
UAS Derived Product Examples



Color Infrared - NDVI



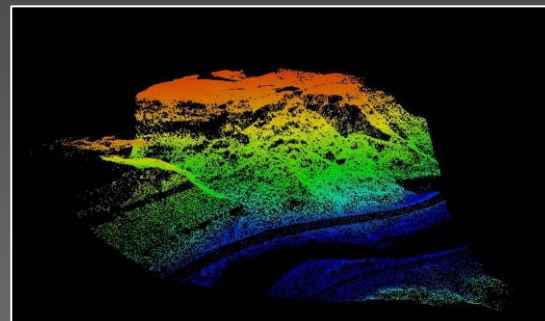
Point Cloud Generation



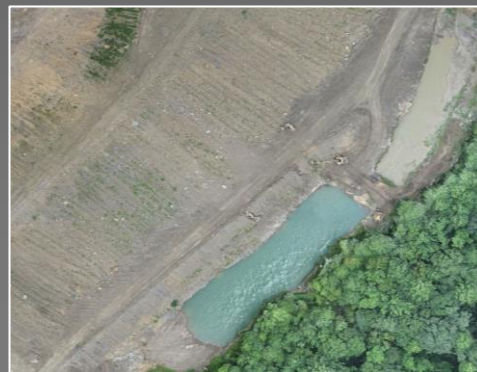
Elevation Models



Feature Extraction



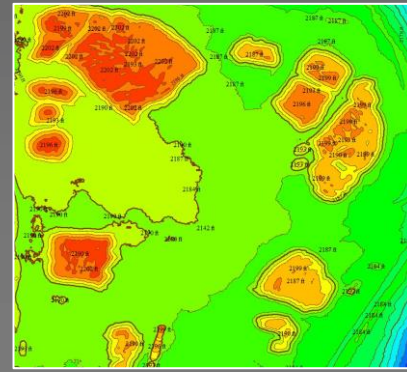
KML - 3D Modeling



Orthophotography

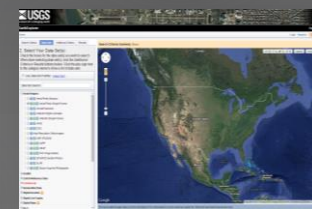
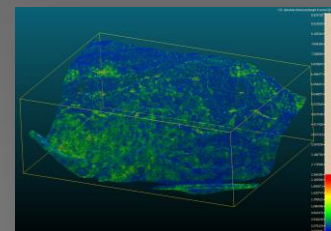
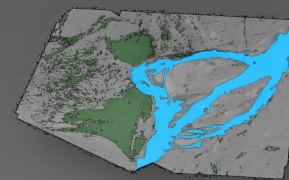
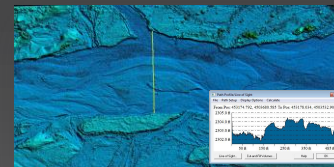
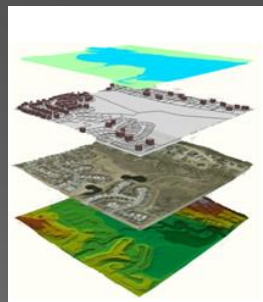
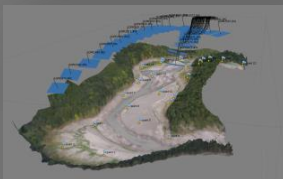
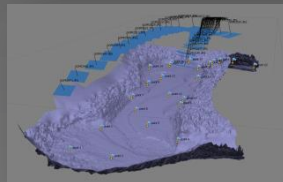
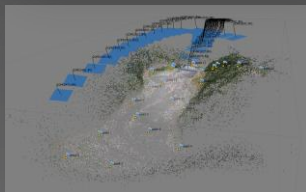
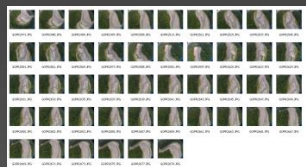


Volumetric Measurements



Contour Generation

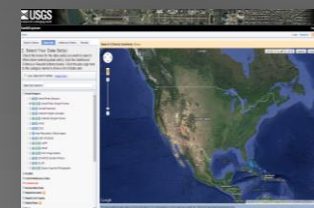
UAS Data Production Process



UAS Data Production Process



The screenshot displays the USGS EarthExplorer web interface. The top navigation bar includes the USGS logo, "science for a changing world", and links for "USGS Home", "Contact USGS", and "Search USGS". The main header shows "EarthExplorer" and a "Page Expires In 1:59:00" timer. Below the header, there are tabs for "Search Criteria", "Data Sets", "Additional Criteria", and "Results". The "Search Results" section is active, showing a list of three data sets. Each data set entry includes a thumbnail image, a title, and a description. The first data set is titled "UAS - Ortho - Pilot Project" and has a description that reads "Entity ID: PPDEBLC020130600C260HS03000001 Acquisition Start Date: 2013/06/01 Sensor Name: Canon PowerShot SX260 HS". The second data set is titled "UAS - Ortho - Pilot Project" and has a description that reads "Entity ID: PPDEBLC020131000C260HS03000001 Acquisition Start Date: 2013/10/01 Sensor Name: Canon PowerShot SX260 HS". The third data set is titled "UAS - Ortho - Pilot Project" and has a description that reads "Entity ID: PPDEBLC020140300SNEX703000001 Acquisition Start Date: 2014/03/01 Sensor Name: SONY NEX-7". To the right of the search results, there is a map showing the location of the data sets. The map is a satellite view of a river valley, with a red rectangle indicating the area of interest. The map includes a scale bar, a north arrow, and a "Search Criteria Summary" box. The "Search Criteria Summary" box shows the coordinates (39° 11' 45" N, 108° 15' 07" W) and a "Clear Criteria" button. The map also includes a "Data Set" section with a "Click here to export your results" link.



Wildfire – Prescribed Burn

UAS Training - Dugway Proving Grounds, Utah



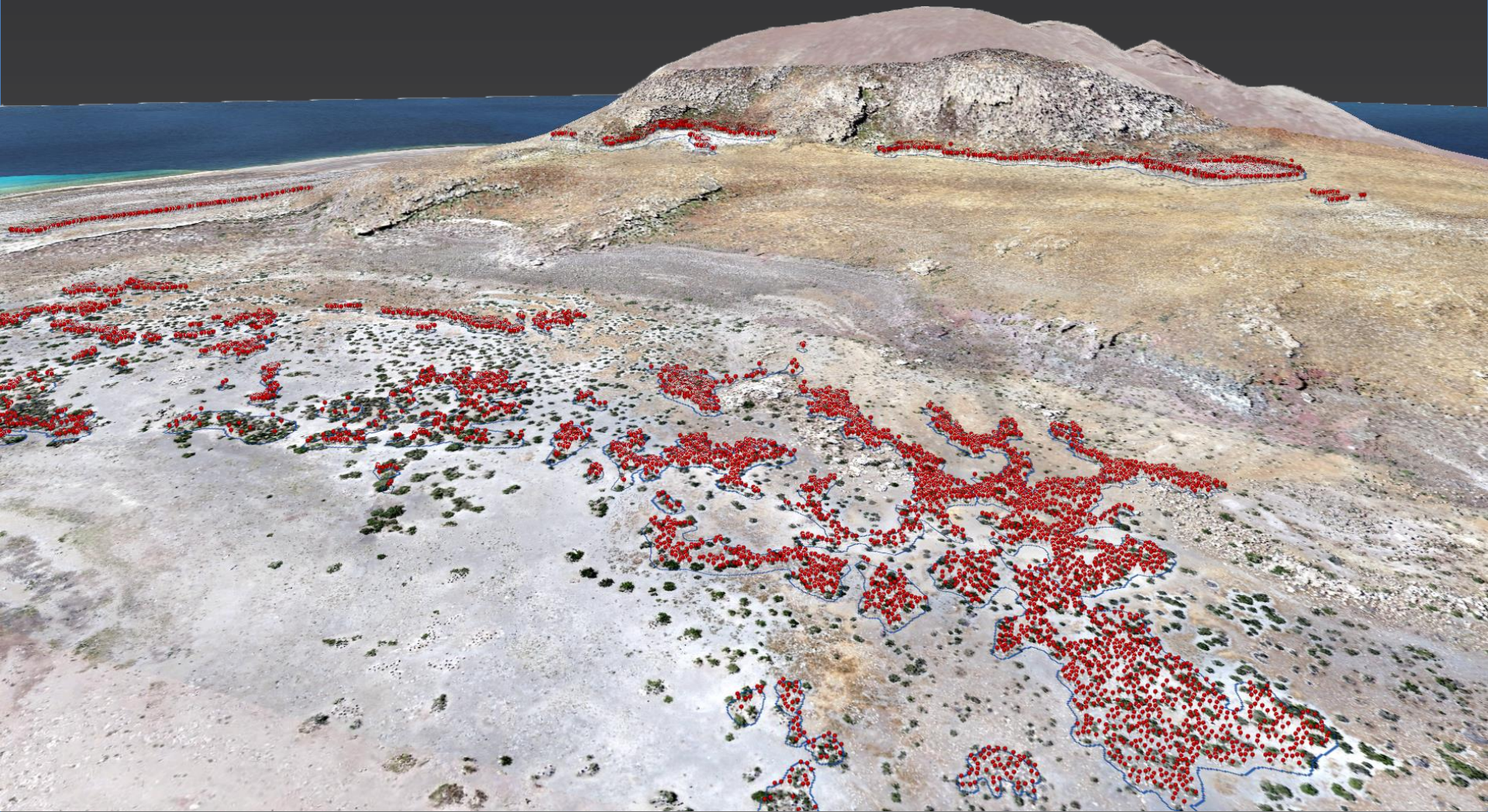
Electro-Optical Video of Prescribed Burn



Infrared Video of Prescribed Burn

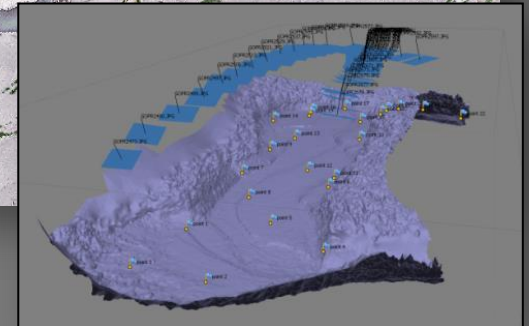
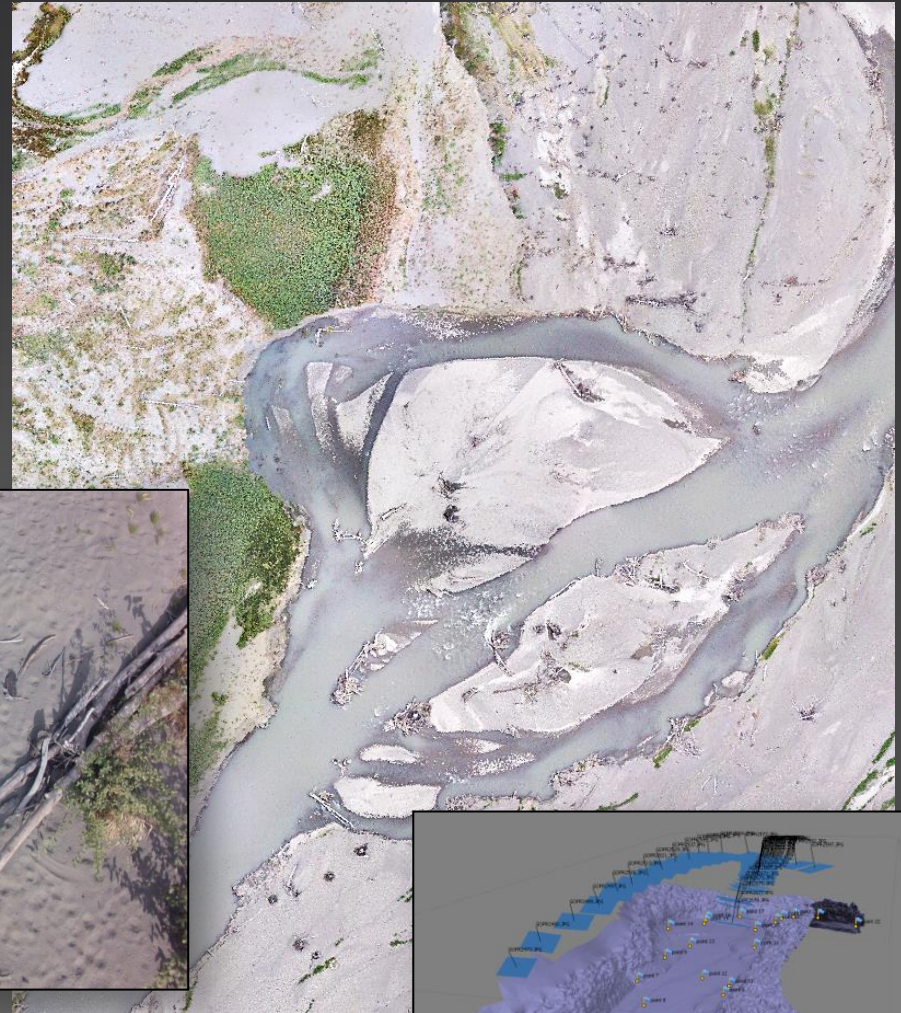
Pelican Nesting Habitats

Pryamid Lake, Reno, NV



Elwha Dam Removal and River Restoration

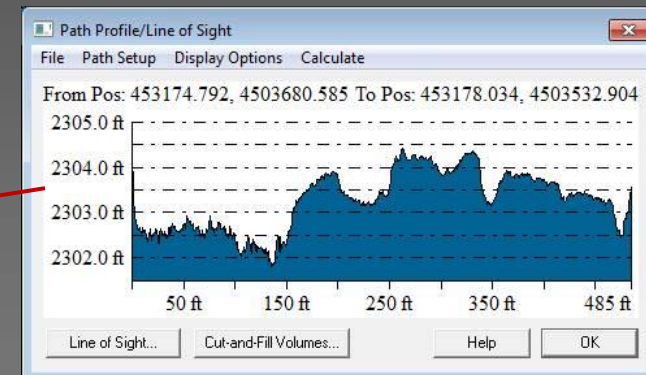
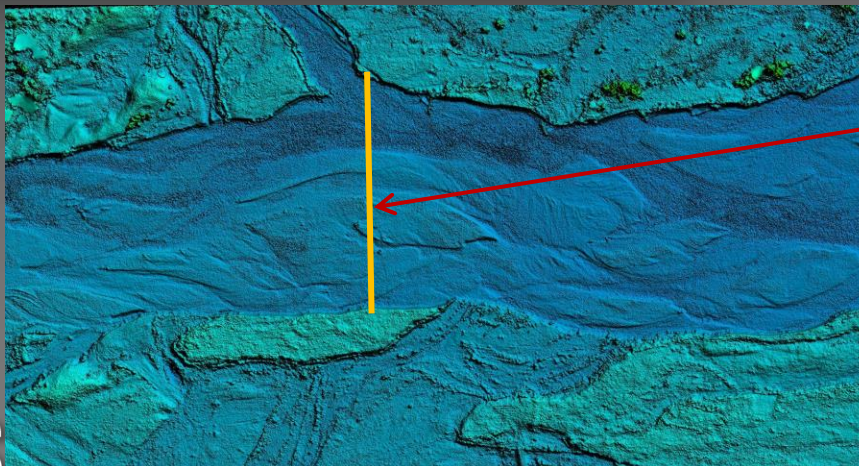
Olympic National Park, Washington



Monitoring sediment volumes eroded from the reservoir and deposited downstream, where the mobile sediment can potentially affect salmon habitat.

Emergent Sandbar Habitats

Platte River, Nebraska

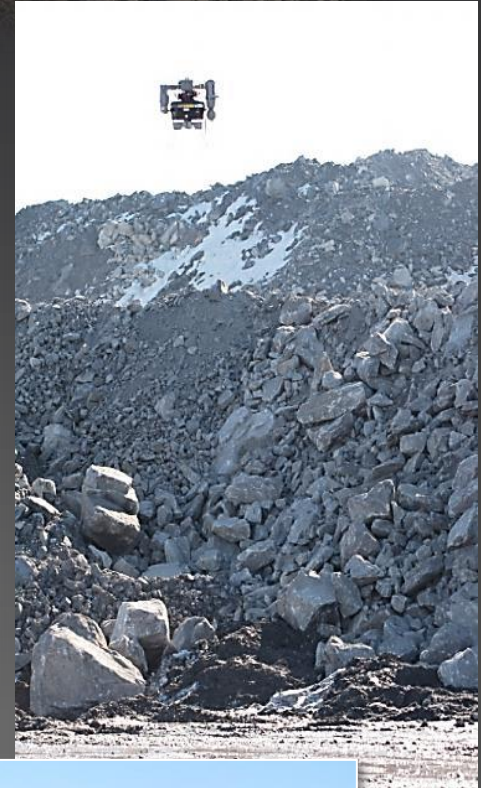


Mapping the spatial extent and elevation of emergent sandbars along two reaches of the Platte River for endangered or threatened nesting birds (least terns and piping plovers)

Mine Inspections

West Virginia – First T-Hawk Mission in the NAS – Nov. 2012
(Office of Surface Mining, BLM, USGS)

Mine permit inspections monitoring a range of topics:
water quality, hazardous conditions, terrain topology, wildlife
habitats, erosion, check dams, and post mining land use



Debeque Landslide

Debeque, Colorado



June 2013



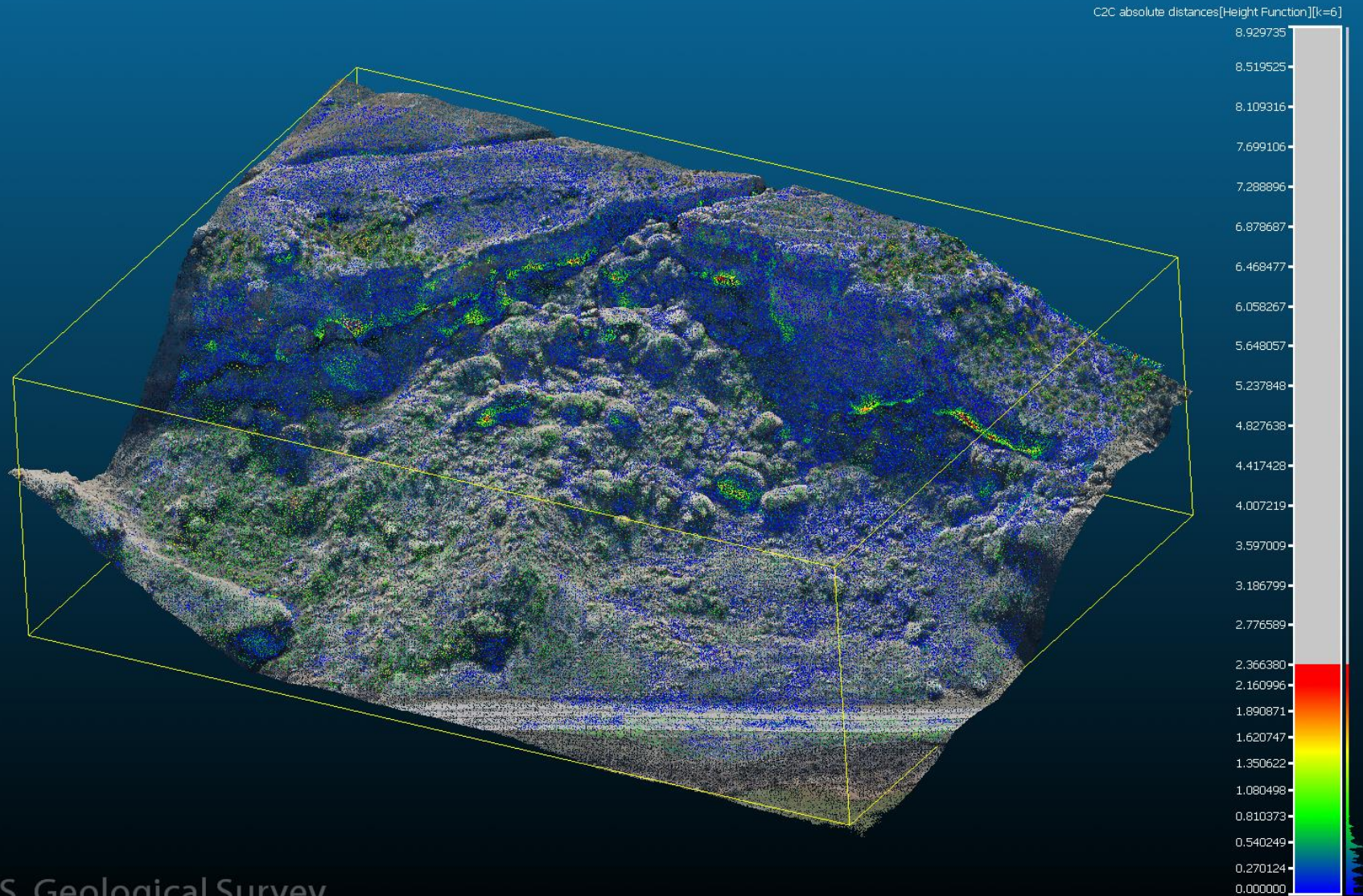
October 2013

Temporal series of
Landslide models
monitoring
geomorphic
processes.



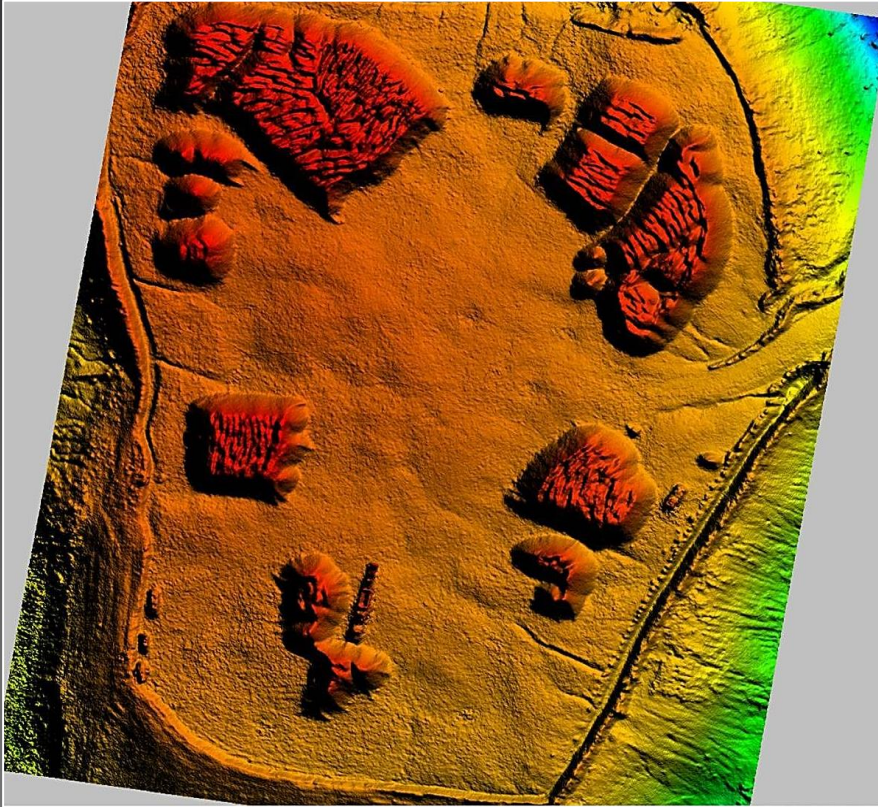
Debeque Landslide

Debeque, Colorado



Mining Stockpile Volumetric Measurements

Kentucky – 2014



Digital Elevation Model Hillshade



Volumetric Measurements
(Cubic Yards)

Lake Havasu, AZ



WorldView 2 – Multispectral (pan sharpened)



UAS – Canon s100 (modified blue filter)

UAS Data Processing

Color Infrared & Normalized Difference Vegetation Index (NDVI)

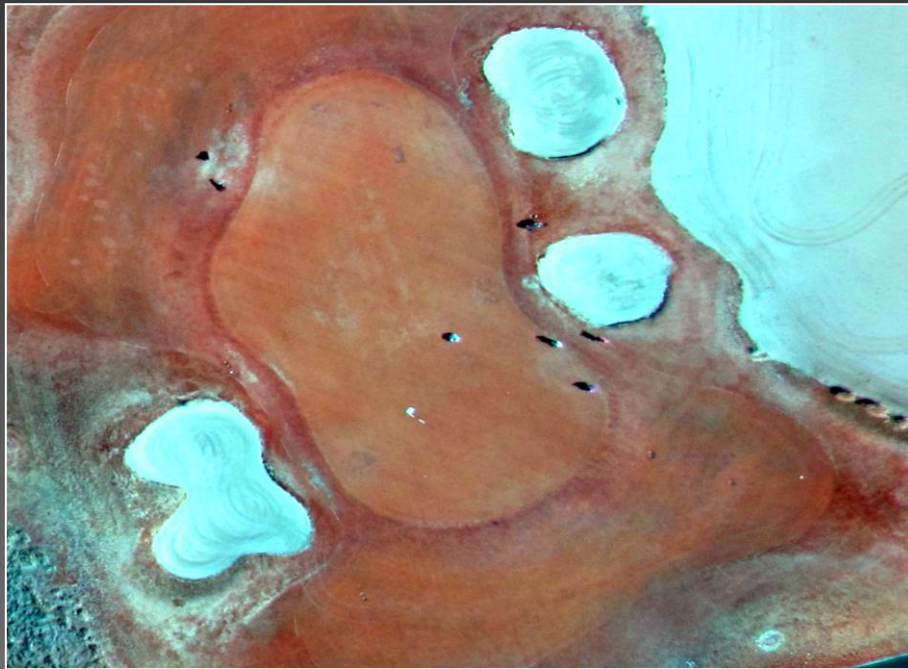
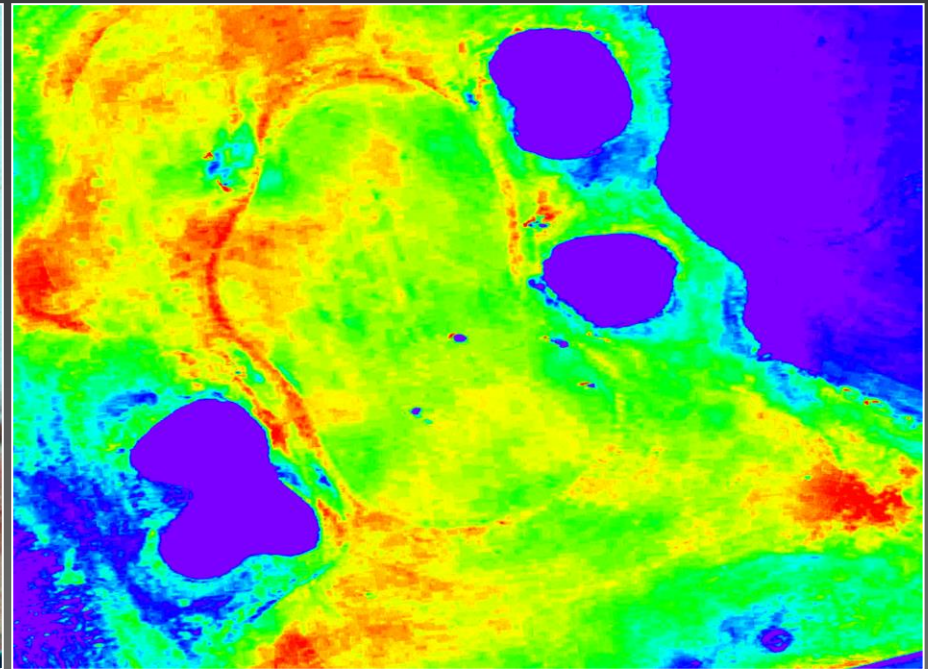


Image collected from UAS – Canon SX230 HS – 400'

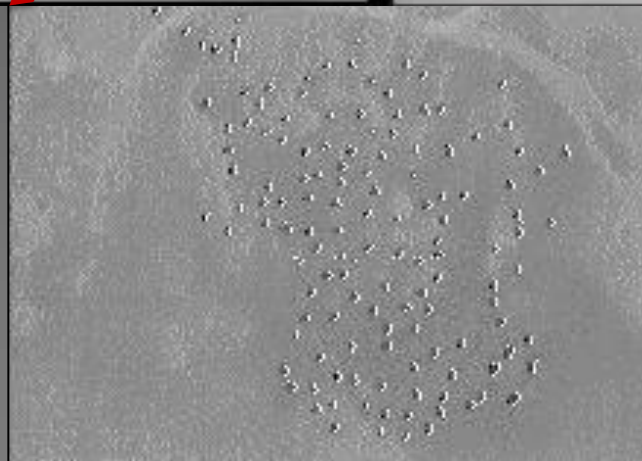


$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

Thermal Sensor Testing

Stock thermal-IR @400ft AGL from analog video and VLC snapshot of Sandhill Cranes

Tau640 thermal-IR @400ft AGL from analog video and VLC snapshot of Sandhill Cranes



Tau640 thermal-IR @400ft AGL
from RAW 14bit digital still of
Sandhill Cranes with "auto"
histogram applied

FAQ

What are the Basic Costs?

Platform

Cameras
Sensors

Collect Data

Process Data

\$300-\$3,000



\$30,000



\$300-\$1,200



\$2,000 - \$6,000



\$25 - \$75/hr



\$3,000





\$6,000



\$400



Will We Be Able to Contract UAS Work?



[USGS Home](#)
[Contact USGS](#)
[Search USGS](#)

USGS Geospatial Data Contracts

COMMERCIAL CONTRACTS

[Geospatial Product and Service Contracts \(GPSC\)](#)

[USGS Geospatial Liaison Guide to the GPSC](#) (PDF file)


[Download the free Adobe Reader](#)

Other Links

[The National Map](#)

[National Geospatial Technical Operations Center](#)

USGS Geospatial Data Contracts



The National Geospatial Technical Operations Center (NGTOC) of the USGS administers a set of Indefinite Delivery Indefinite Quantity (IDIQ) contracts through a competitive process, which provide a mechanism to obtain geospatial data services throughout the United States. The contracts primarily support *The National Map*, but they are flexible enough to be used by other Federal, State, and local agencies. The Geospatial Product and Service Contracts (GPSC) is a suite of contracts, broad in scope, that can accommodate activities related to standard, nonstandard, graphic, and digital cartographic products. Services provided may include: photogrammetric mapping and aerotriangulation; orthophotography; thematic mapping (for example, land characterization); digital imagery applications; IFSAR and LiDAR; geographic information systems development; surveying and control acquisition, including ground-based and airborne GPS; and much more.

NGTOC personnel have been providing technical support to digital cartographic services contracts for over twenty years. This technical expertise supports the contracting officer services provided by the Office of Central Region Services, Acquisition and Grants Branch in Denver, CO. For further information on how the NGTOC can provide Federal, State, and local agencies with access to these contracts, please send inquiries to gpsc@usgs.gov.

[Accessibility](#) [FOIA](#) [Privacy](#) [Policies and Notices](#)

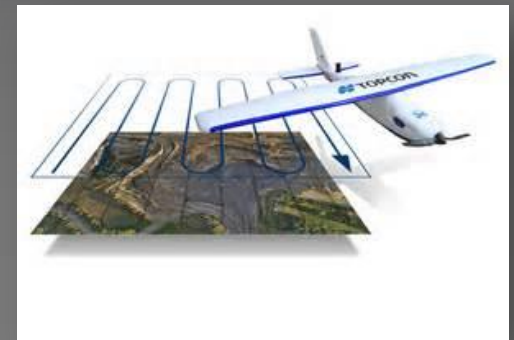
Geospatial Product and Service Contracts (GPSC)

FAQ

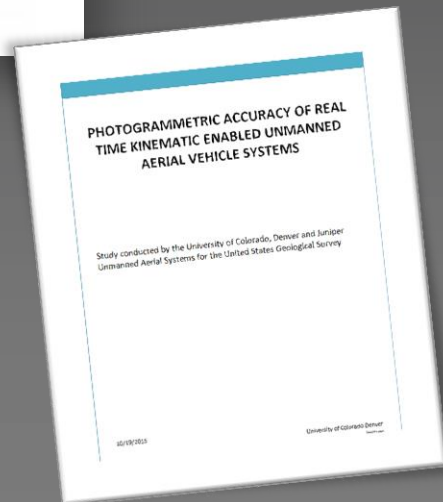
Can We Cooperate with Universities?



COOPERATIVE ECOSYSTEM
STUDIES UNITS
NATIONAL NETWORK



Can We Cooperate with Universities?

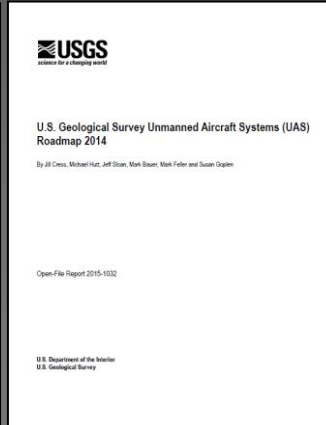
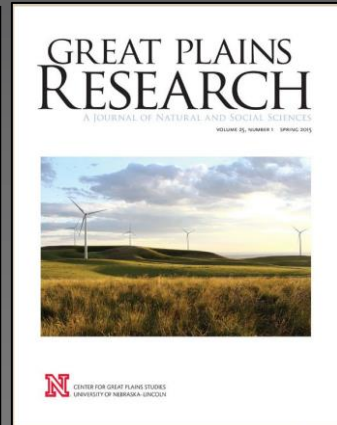
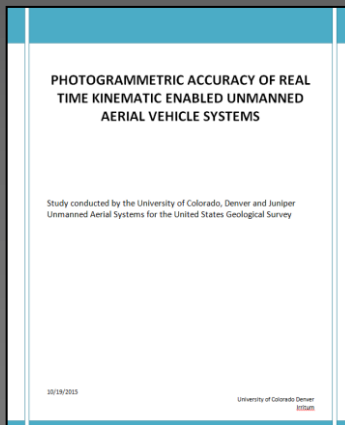
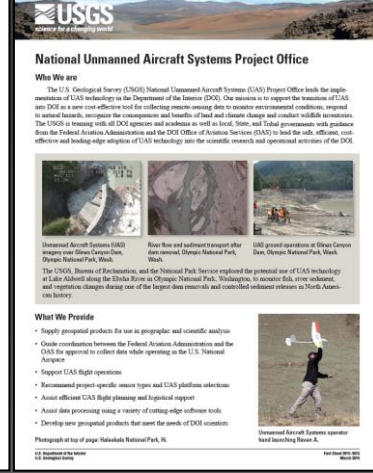
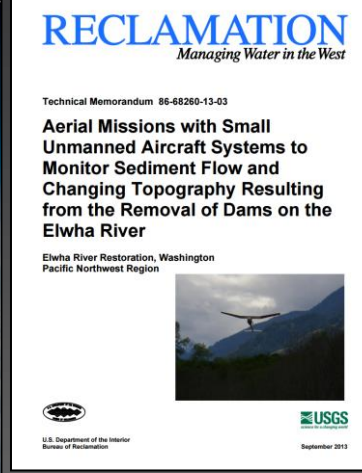
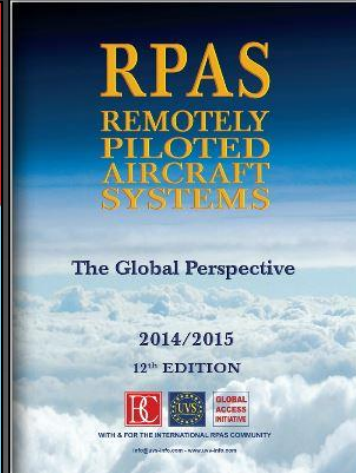
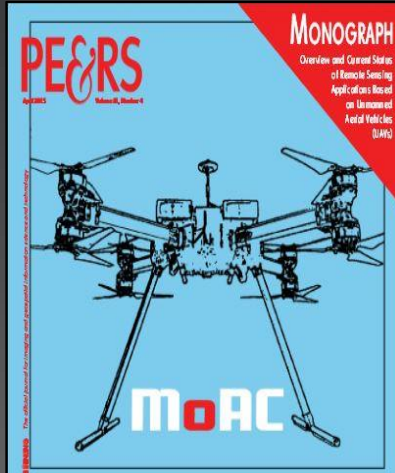
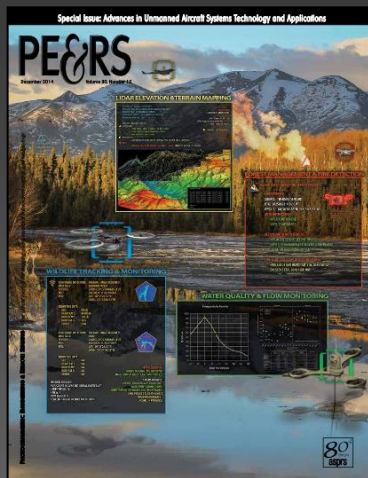


RTK - realtime differential correction 5-15cm

FAQ

Can the Data Be Published?

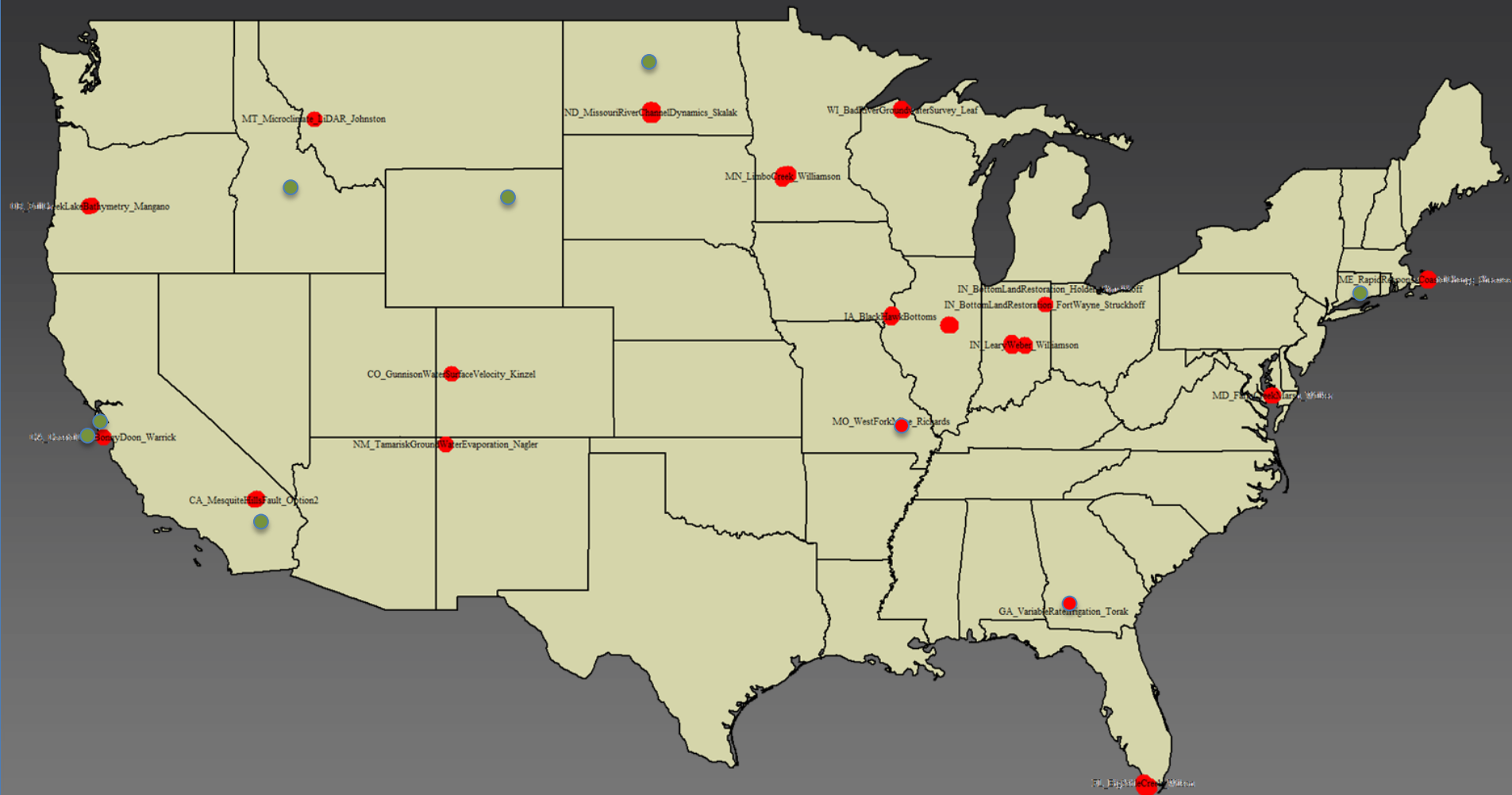
Peer Reviewed Publications:



2016 USGS UAS Work

- Microclimate Studies
- Surface Water Dynamics
- Ground Water Surveys
- Agricultural Tile Line Surveys
- Tamarisk – Ground Water Surveys
- Fault Line Surveys
- Coastal Erosion
- Coastal Cliff Morphology
- Paleowetland Surveys
- Asian Carp, Waterfowl, Sea Turtle, Fur Seal Surveys
- Mine Surveys

2016 USGS UAS Work



USGS UAS National Project Office

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