

Emerging Geospatial Techniques in Education and Outreach: Augmented Reality, Elephants and Gardens



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UNIVERSITY OF
GEORGIA

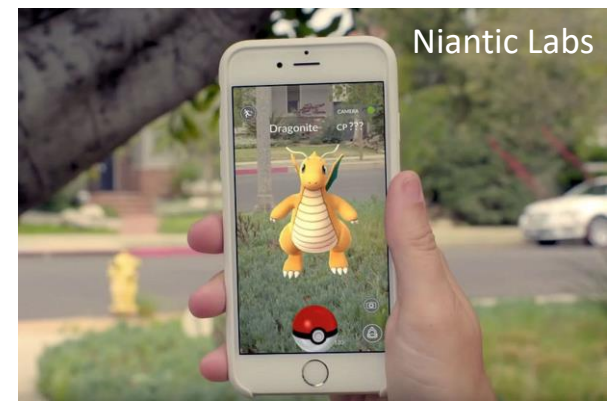
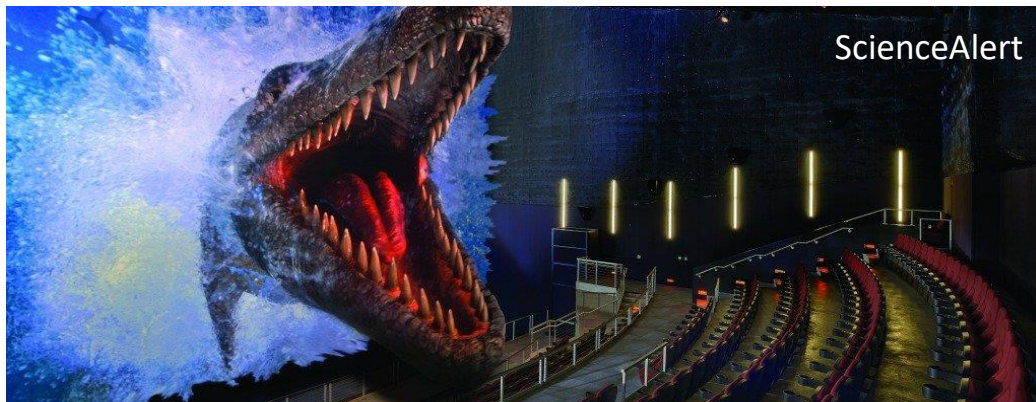
UN World Geospatial Information Congress
19-21 November 2018, Deqing, China

CGR
Center for Geospatial Research 

Motivation



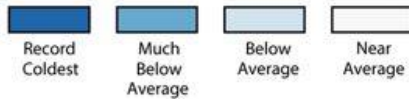
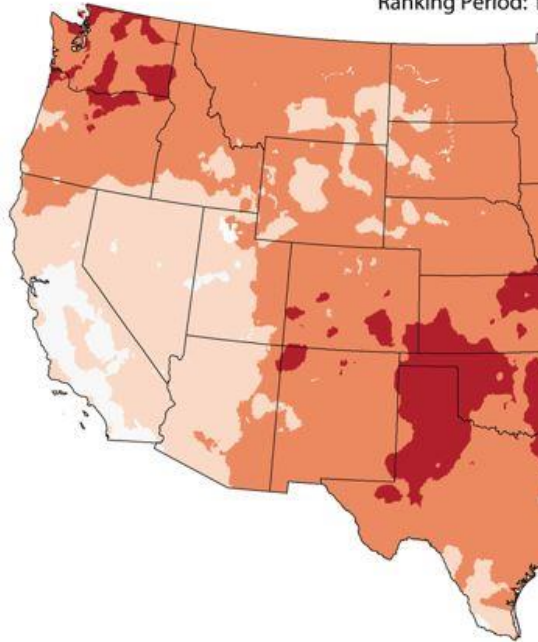
- Students are increasingly visual learners
- Come to university with expectations regarding use of technology in learning
- Need for geography-ready immersive technologies that support visual & experiential learning
- Availability of software and hardware tools to integrate those technologies



Motivation-Records are breaking

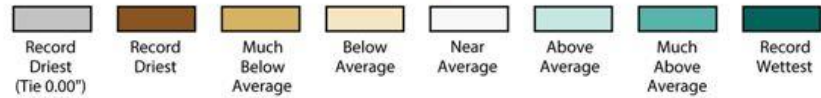
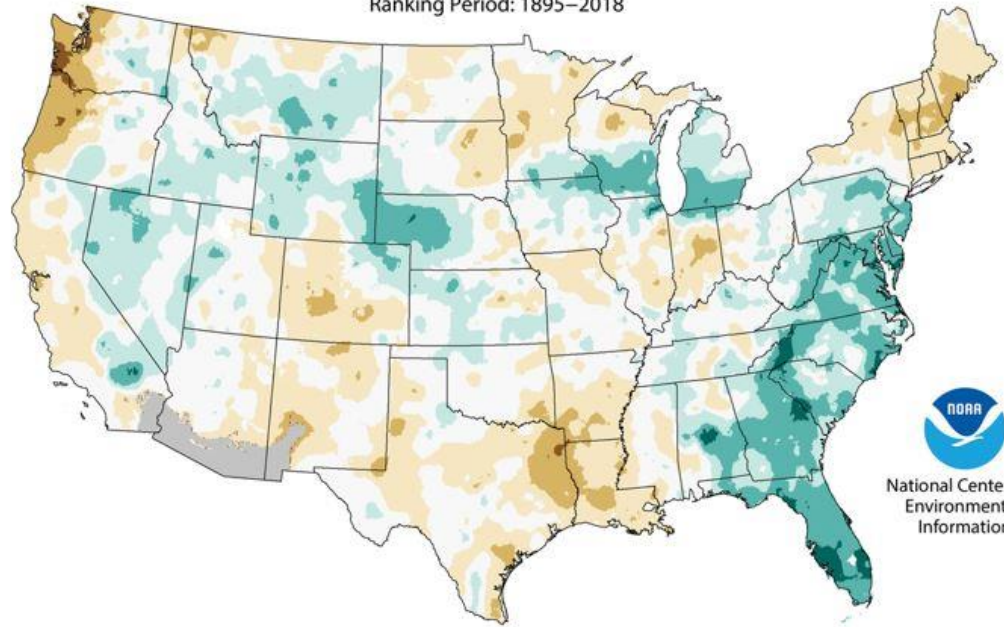
May Temperature

Mean Temperature
May 20
Ranking Period: 1



May Precipitation

Total Precipitation Percentiles
May 2018
Ranking Period: 1895–2018



National Centers for Environmental Information

Created: Mon Jun 04 2018

Data Source: 5km Gridded Dataset (nClimGrid)

Created: Mon Jun 04 2018



Motiva weath

Hurricane Michael, 8 October 2018

Hurricane

- 2017 Atlantic
- 17 named s
 - 10 became
 - 6 were major



Pacific Ocean

Pos: 56.27, -13



Hurricanes

County Strikes

POWERED BY esri

New Legend



Objectives

Introduce 3DIG (3D Immersion and Geovisualization) System for research, education and outreach.

Two research studies using remote sensing and 3DIG:

- UAS, Virtual/Augmented Reality for **agricultural** monitoring and visualization of crop health.
- Geospatial approaches to monitor and mitigate **elephant-human conflicts** in Zimbabwe.

Objectives – In automation, remember power of visualization

Seeing is believing and understanding both imagery and the products of algorithms (e.g., unsupervised classification, GEOBIA, Deep Learning):

- We bring our life experiences/perceptions/values to our computer screens.
- Understand the image features *before* we process.
- Image interpretation is critical to assessment of (*after*) segmentation, classification and image object quality.
- Explore new technologies (VR/AR) + GEOBIA/Deep Learning

The 3DIG System



UAS images to Unreal Engine VR/AR and digital sandbox

3D models with Photogrammetry



UAS images + 3D point clouds display on video wall

3D Immersion and Geovisualization (3DIG)

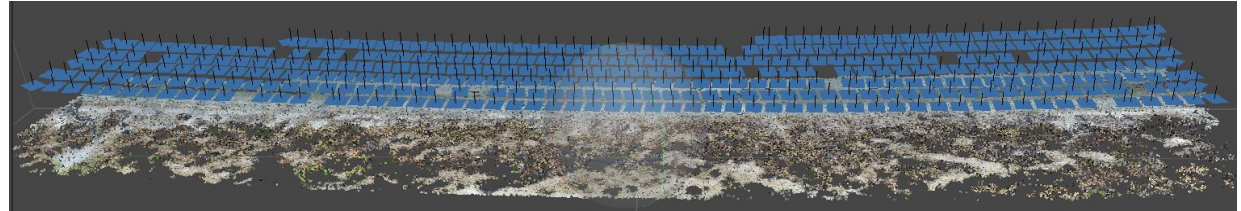


VR/AR + model output displayed on digital sandbox

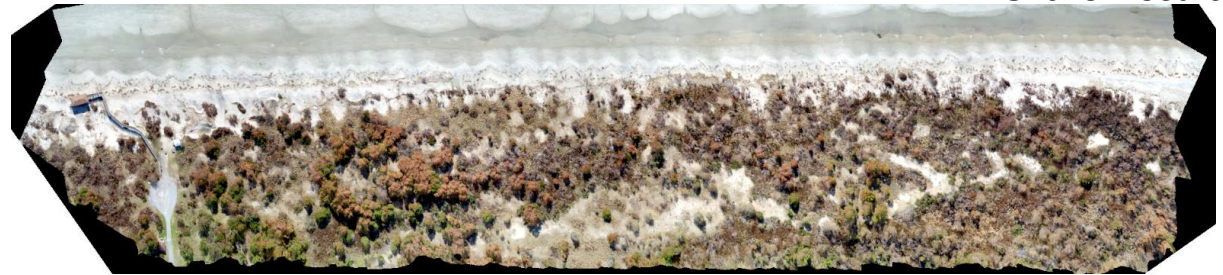


3DIG: Unmanned Aerial System

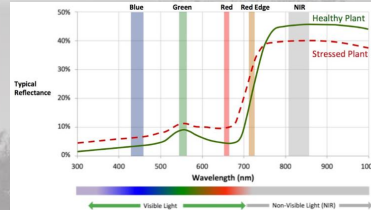
3D point cloud



Orthomosaic



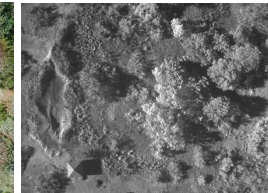
Multidimensional datasets



RGB



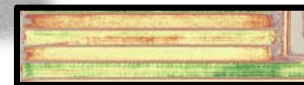
Near Infrared



Red Edge



...



Vegetation Index

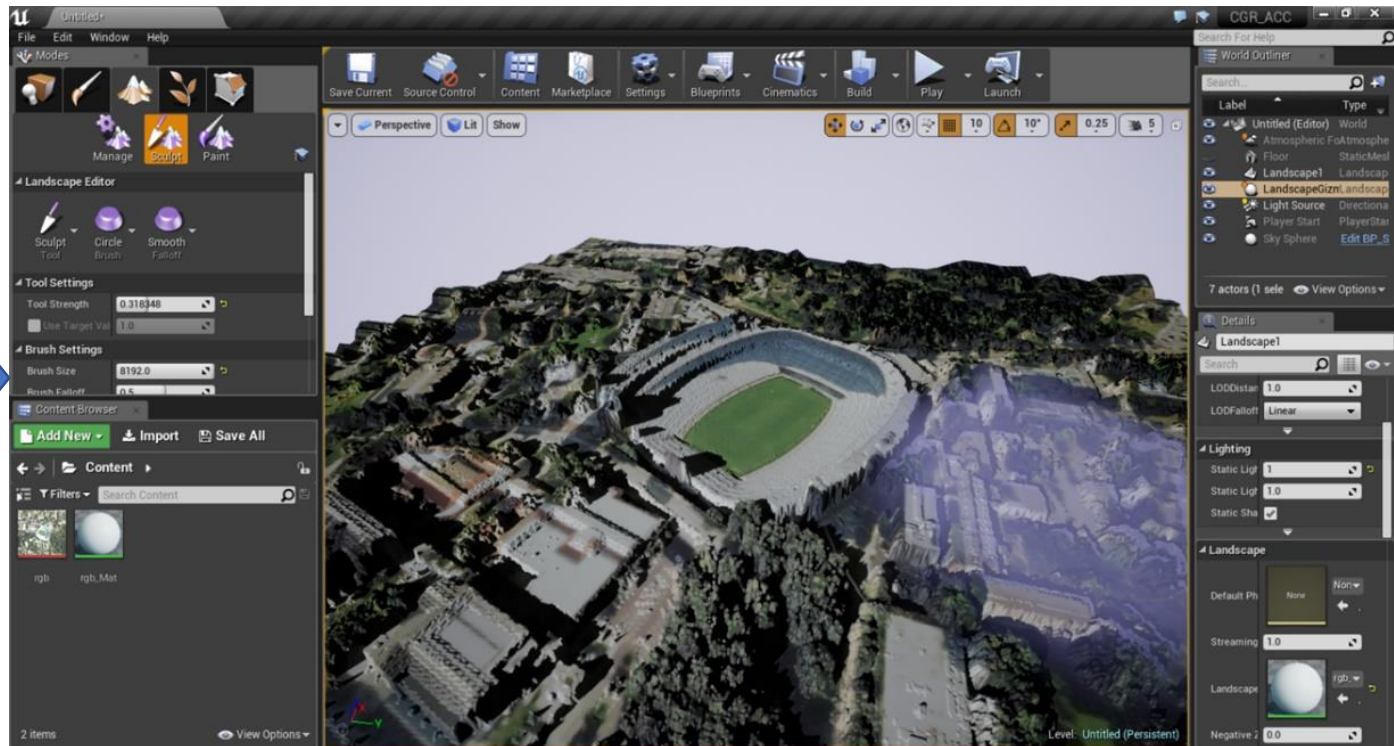


3DIG: Virtual Reality

Realistic representations of landscapes (gaming engine: Unreal Engine)



Point clouds
from UAS and
LiDAR data



3DIG: Virtual/Augmented Reality



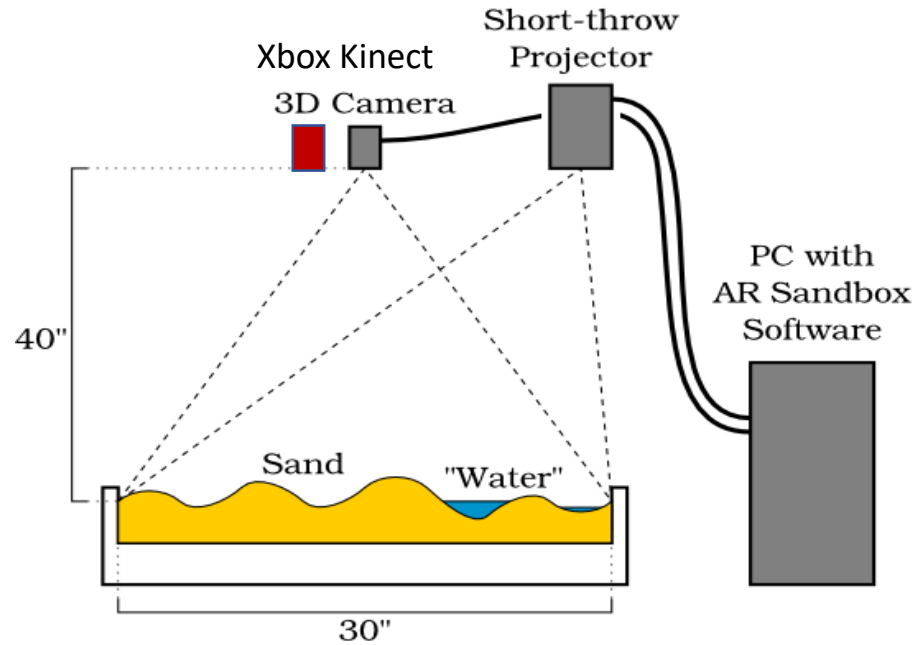
2 Oculus VR goggles



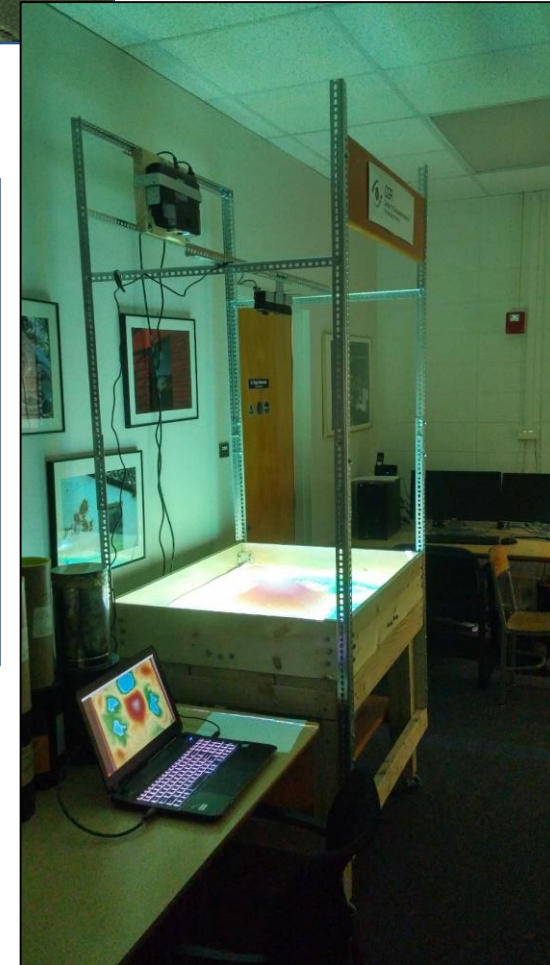
2 Microsoft HoloLens AR Goggles



3DIG: Augmented Reality



- Raised sandbox
- Distance/depth sensors
- Gaming computer
- Projector
- Highly interactive (near real-time response)
- Modeling
- Testing of what-if scenarios

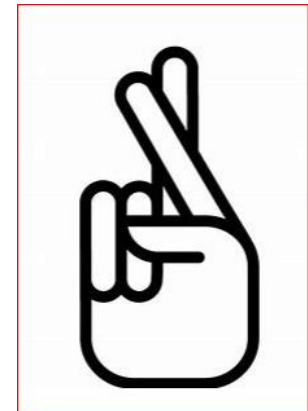


3DIG: Video Wall

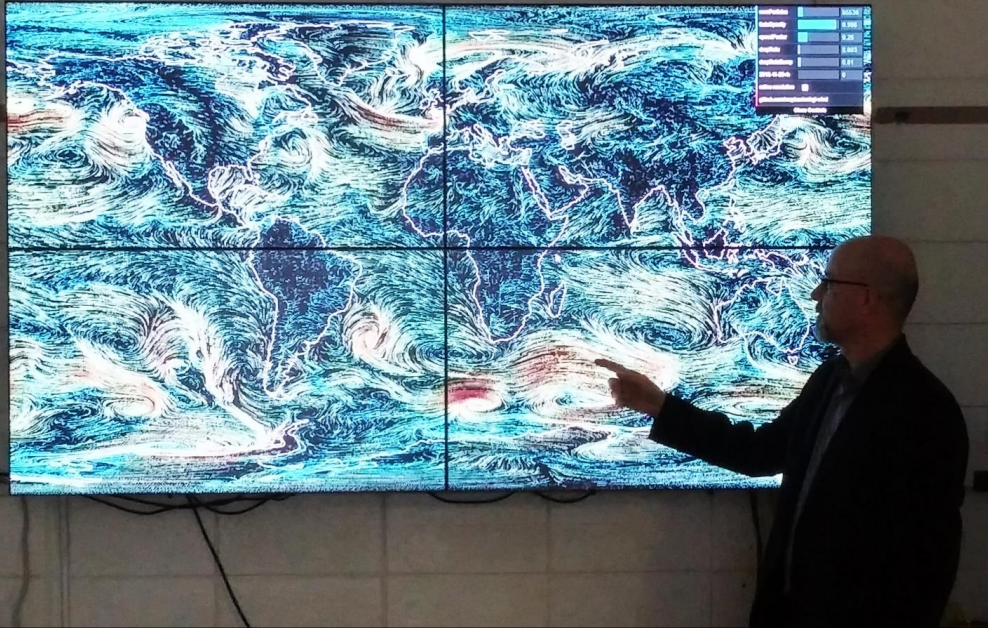
NASA



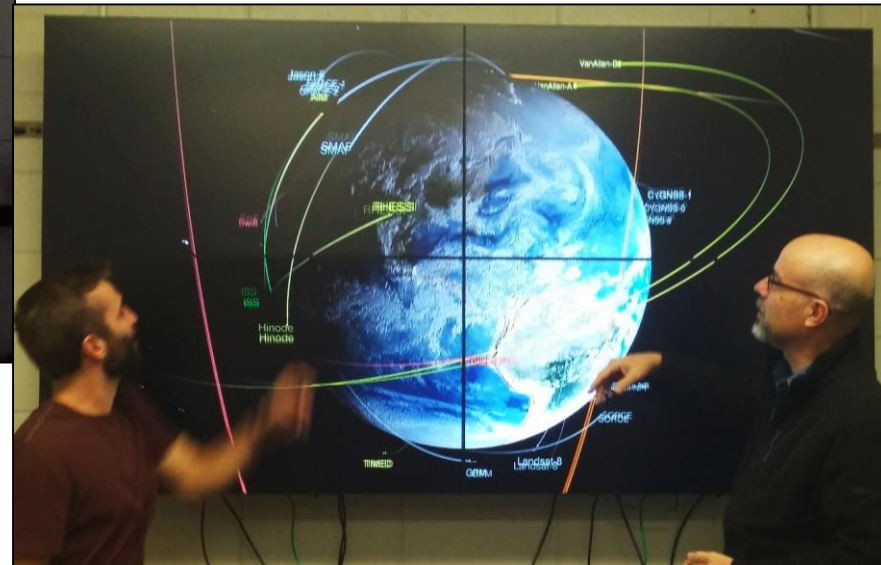
- Visualizations and demonstrations
- Inspired by NASA's Hyperwall
- Nine 46" displays (3 x 3 configuration)



3DIG: Video Wall



Reality =
Four 46" displays
(2 x 2 configuration)



3DIG: Education and Outreach

Event	Location	Date	Estimated Audience
GIS Day 2016	Main Library at UGA	11/16/2016	~100
Morgan County High School tour	Geography/Geology building (CGR)	02/17/2017	46
Demonstration to Geography and Geology	Geography/Geology building (lobby)	03/02/2017	Over 150
American Society for Photogrammetry and Remote Sensing conference	Baltimore, Maryland	03/16/2017	~20
Seminar in Advanced Remote Sensing, class. Joint with class from College of Environment + Design	Geography/Geology building (classroom)	03/24/2017	~20
Introduction to GIScience, class	Geography/Geology building (classroom and CGR)	04/17/2017	25
MapTime Athens presentation	Hendershot's Coffee	04/25/2017	~10
Middle schoolers' tour	Geography/Geology building (CGR)	06/07/2017	~20
NASA DEVELOP closeout	Geography/Geology building (classroom)	08/08/2017	25
Aerial Photographs and Image Interpretation, GEOG 4330/6330, class	Geography/Geology building (CGR and classroom)	09/08/2017	20
Presentation at Science Library (co-sponsored by the UGA Student Chapter of the American Society for Photogrammetry and Remote Sensing)	Science Library at UGA	09/13/2017	> 1000
First Year Odyssey Seminar - Human Impact on Landscapes of the World	Geography/Geology building (CGR)	09/14/2017	15
First Year Odyssey Seminar - They Know Where You Are! GIScience & GI Technology	Geography/Geology building (CGR)	09/20/2017	15
Aerial Photographs and Image Interpretation, class	Geography/Geology building (lawn in front of Geography/Geology)	09/22/2017	15
Introduction to Physical Geography, GEOG 1111, lab (M.S. student David Rickless)	Geography/Geology building (lab)	09/06/2017	50
Introduction to Physical Geography, lab (PhD student Flavia Moraes)	Geography/Geology building (CGR)	09/25/2017	50
First Year Odyssey – Spatial Thinking-Google Maps and Beyond, College of Environment + Design	Geography/Geology building (CGR)	11/7/2017	15
GIS Day 2017	Main Library at UGA	11/15/2017	?
Introduction to Physical Geography, lab (PhD student Flavia Moraes)	Geography/Geology building (CGR)	01/24/2018	30
Introduction to Physical Geography, lab (PhD student Flavia Moraes)	Geography/Geology building (CGR)	01/25/2018	30
Demonstration to Athens Montessori Middle School	Geography/Geology building (CGR)	01/31/2018	15
TOTAL			Over 1500

- + 30 events (GIS Day, classes, demos)
- over 1500 students exposed to technology

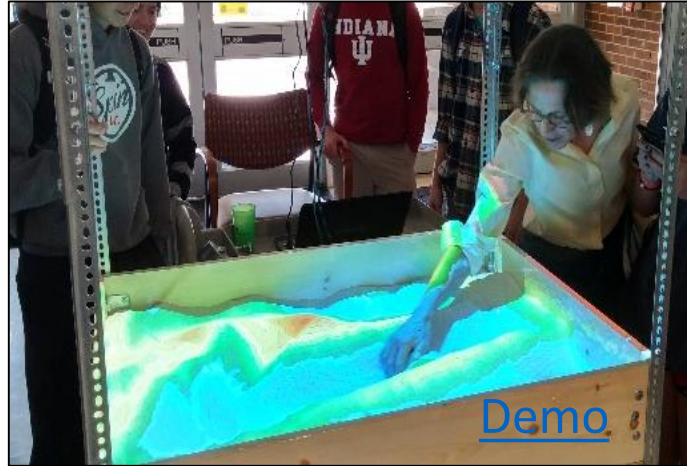


- Students and sandbox "on-the-road"
- Casters replaced

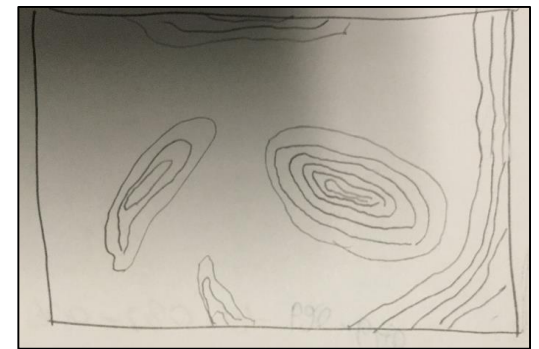
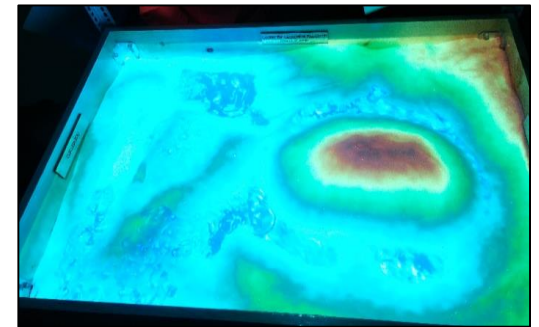


- Large crowd of students, faculty and staff around the AR sandbox at a library

3DIG: Education and Outreach



- Demonstration to local community
- Use in teaching and learning



3DIG: Education and Outreach

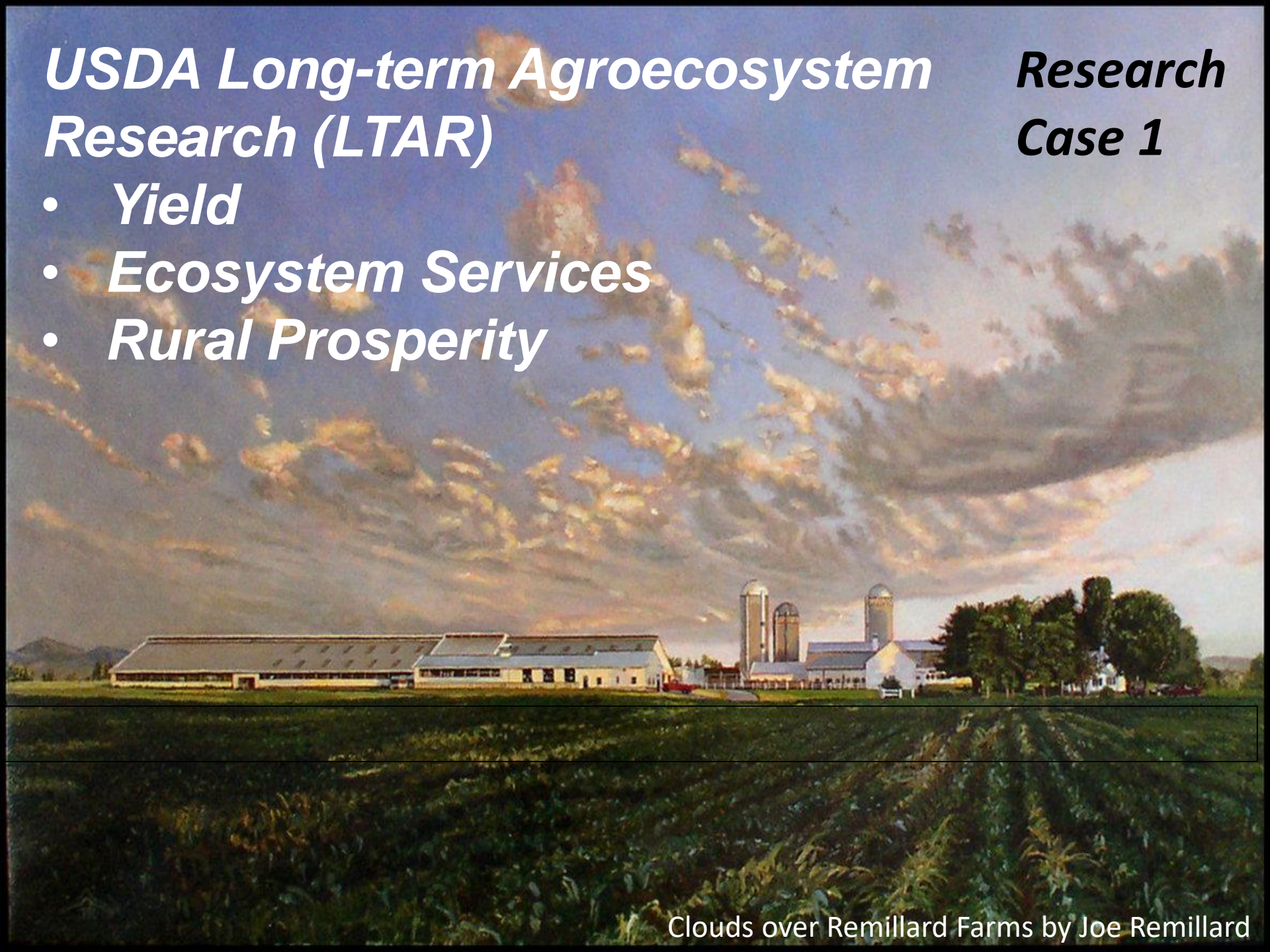
- UAS flight instruction and preparation for a flight lesson.
- Hands-on flight lessons.
- Students attend a demonstration on UAS and experience first person view.



USDA Long-term Agroecosystem Research (LTAR)

- *Yield*
- *Ecosystem Services*
- *Rural Prosperity*

Research Case 1



UAS + MicaSense RedEdge Sensor

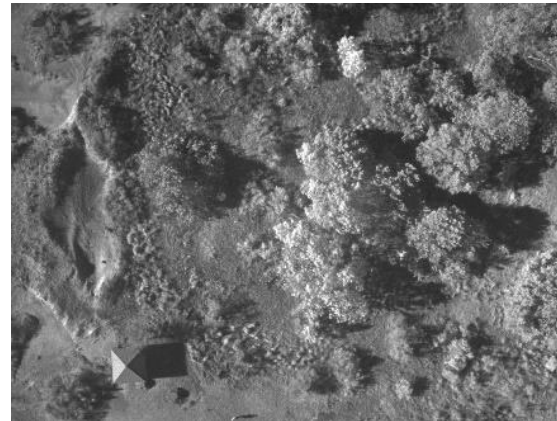


MicaSense RedEdge

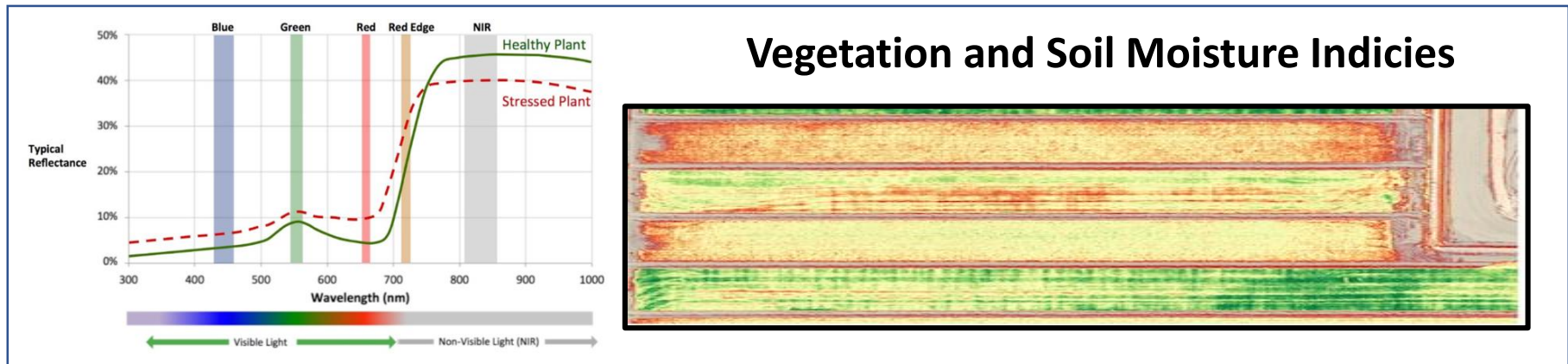
RGB



Near Infrared



Red Edge



Planting Collard Varieties - Coastal Georgia, Isle of Hope

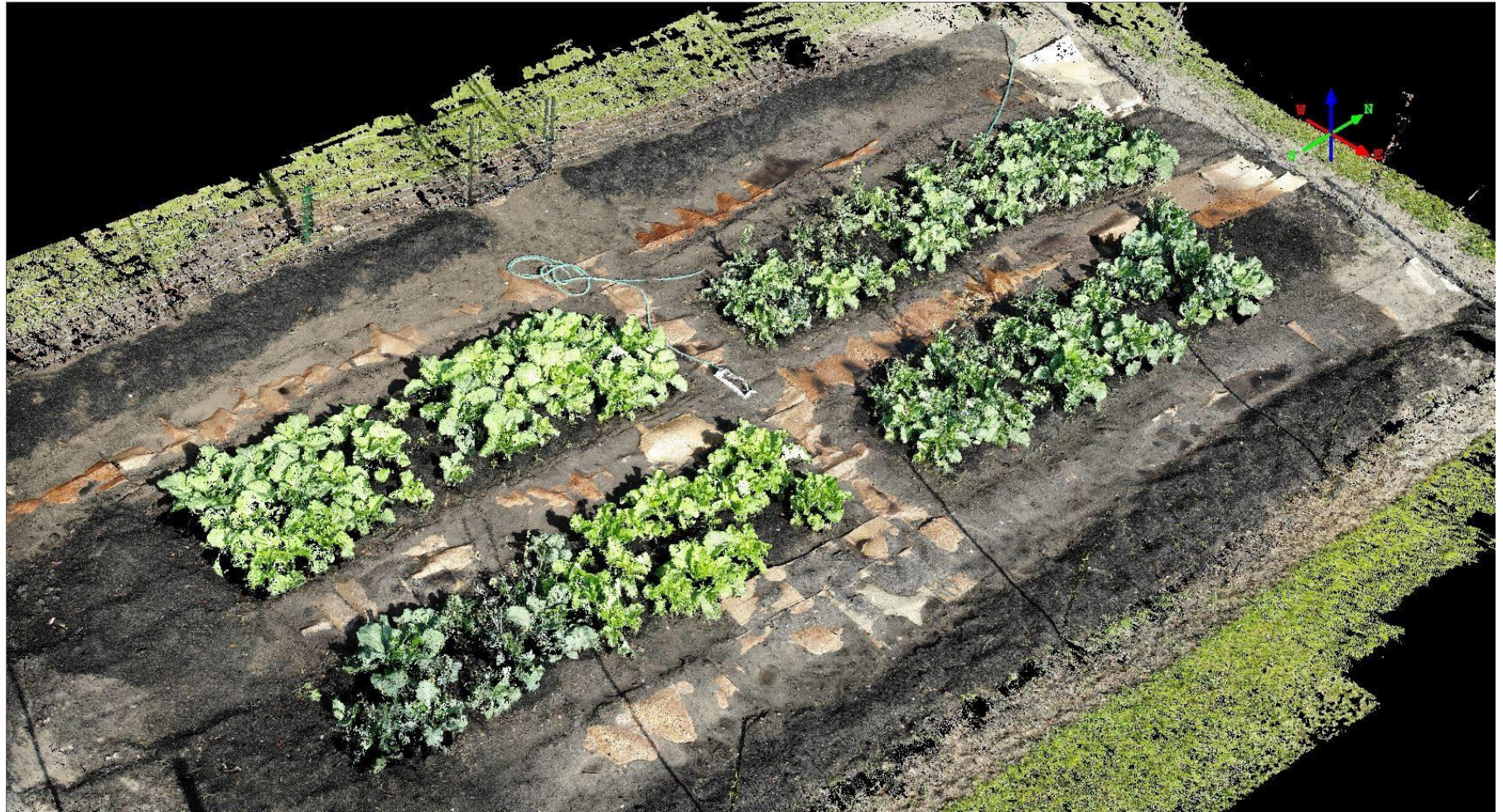


Growing traditional and heritage varieties of collards – Southeast Coast
Assessing adaptation to changing climate (heat and drought)
Saving seeds to preserve phenotypic responses to drier/hotter conditions

Outreach to small farm farmers and promote farm-to-table



UAS imagery-derived 3D Point Clouds of Collards



Goal is to quantify structure and spectral responses to stress

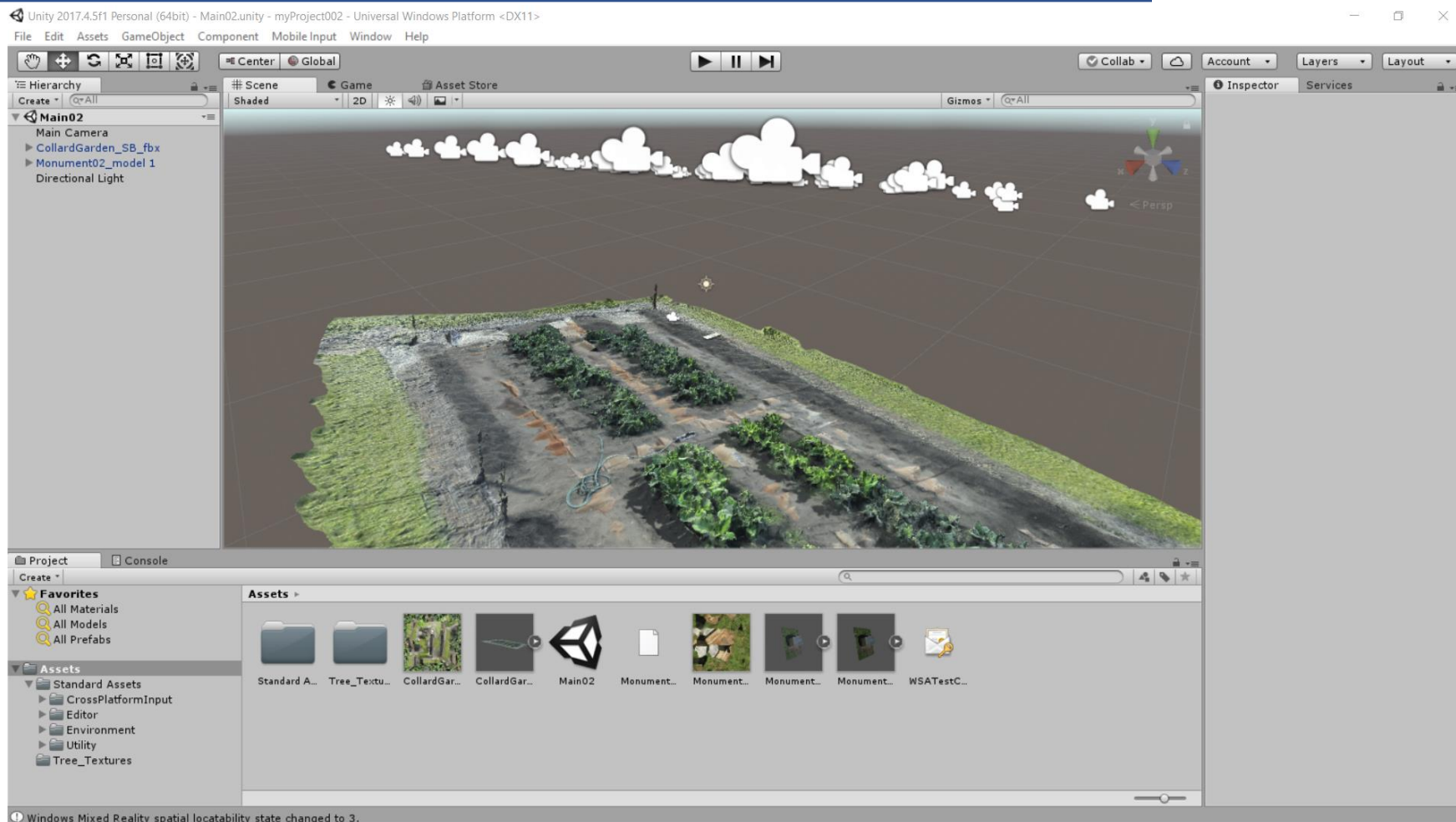


<https://youtu.be/99zr8aPce-M>



Augmented Reality to visualize vegetation stress responses

Gaming
Software:
Unity



AR brings field visualization to the lab = aid to verification



Microsoft HoloLens to “see” the *in situ* collards in the lab



Elephant-Human Conflict in Africa (Zimbabwe)

Research Case 2

Vehicle collisions when elephant groups travel along natural corridors between National Parks



Crop raiding, especially in fields adjacent to National Parks

Kavango-Zambezi Transfrontier Conservation Area (KAZA-TFCA)

Study Area centered on Victoria Falls



Mitigate with chili pepper spray



Mitigation using chili peppers local farmers grow and hit elephants with pepper spray.

GPS Collars on 10 large bulls



Tracking bulls' movements on our cell phones

Mobile App
SKY-Q Mobile
by Skygistics



Verizon LTE 5:53 PM

Unit Browser

Search: No

- 2018-03-16 17:00:32 Moving
01224111SKY8EA8
3515.63 km from GPS Origin - 0 km/h
- 2018-03-16 17:00:32 Moving
01224124SKY42E9
3517.06 km from GPS Origin ;Zanguja - 0 km/h
- 2018-03-16 17:45:32 Moving
01224136SKY7325
3512.30 km from GPS Origin ;Zanguja - 0 km/h
- 2018-03-16 17:45:32 Moving
01224138SKY7B2F
3458.49 km from GPS Origin ;Victoria Falls - 0 km/h
- 2018-03-16 17:45:32 Moving
01224139SKYFF34
3437.53 km from GPS Origin - 0 km/h

Verizon 12:19 AM 65%

Map Browser

Map Satellite

Victoria Falls National Park

Log out Units Drivers Ice Cold Maps

vodafone UK 3G 2:29 AM 67%

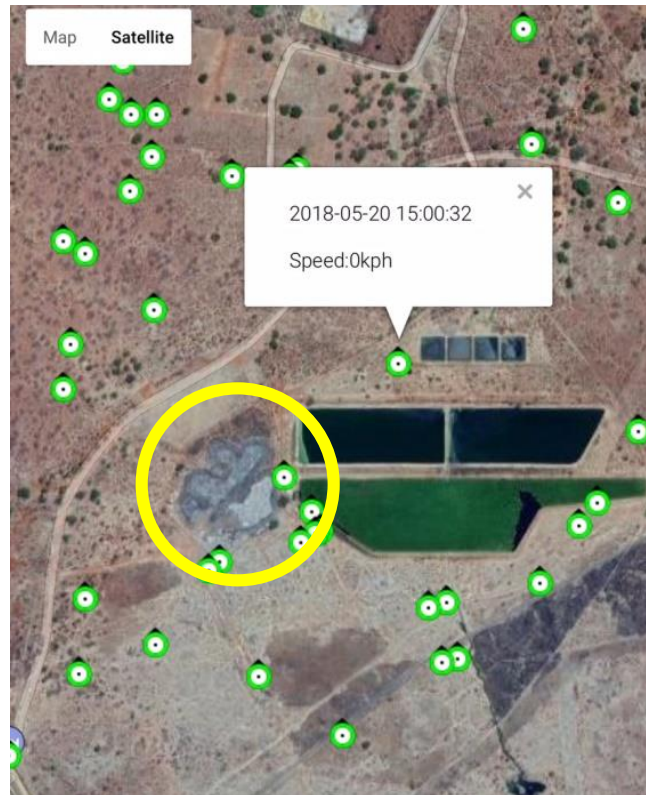
Replay Browser

Map Satellite Labels

Log out Units Drivers Ice Cold Maps



Loki-6 and Loki-7 are eating in Victoria Falls rubbish dump

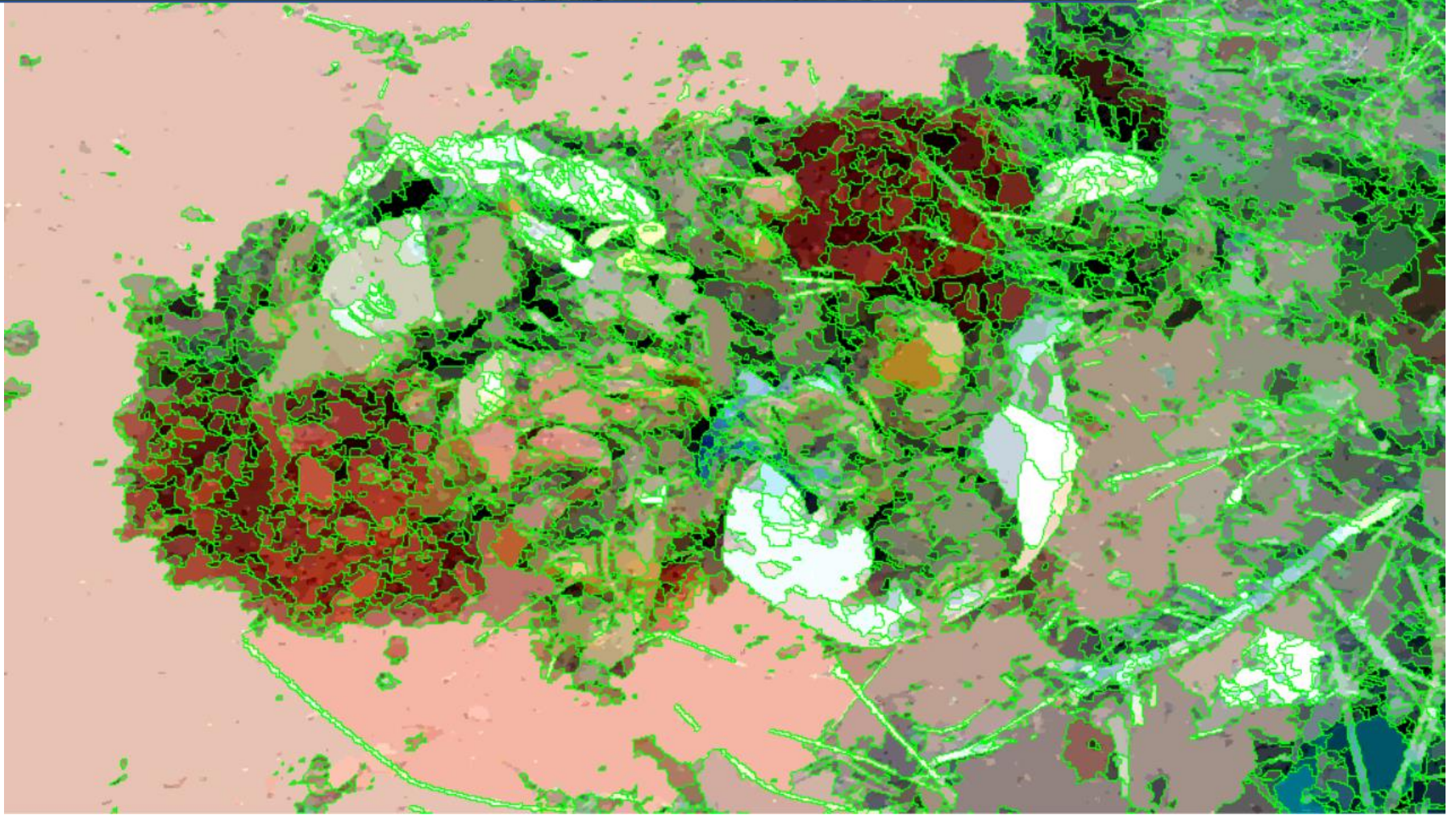


Loki6 and Loki7 are eating garbage and drinking from water treatment ponds.

Photo - elephant dung, plastic and dung beetle-turned soil



Segmentation, supervised classification, merging

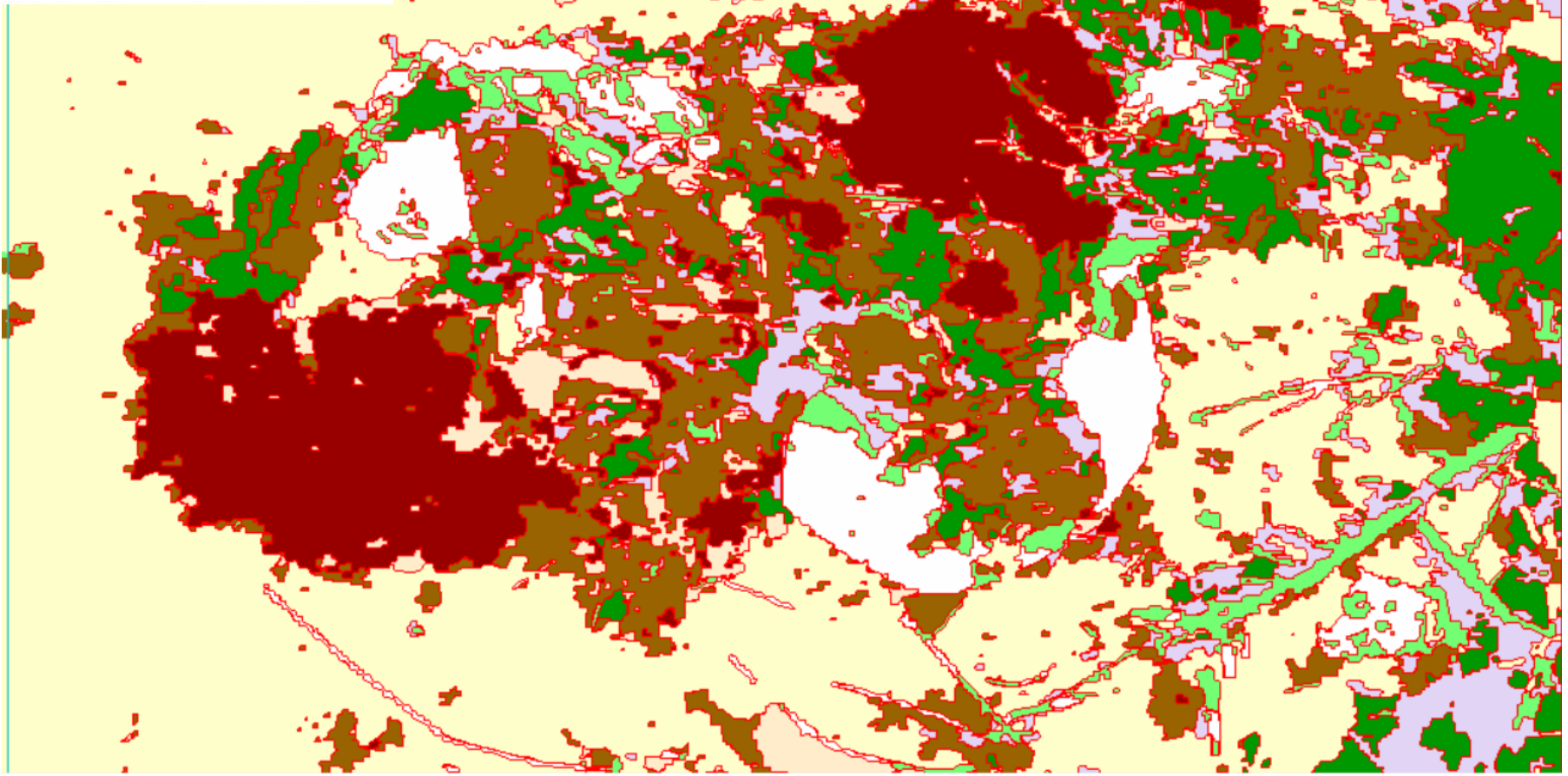


Classify dung, dung beetle, colors of plastics, soil, vegetation

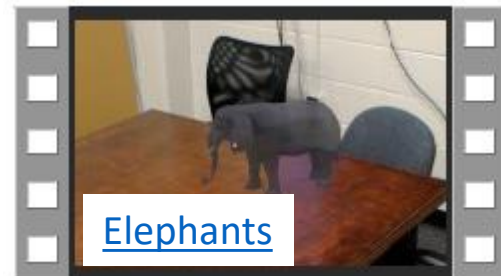


- Dung beetle (16 objects)
- White plastic (21 objects)
- Blue plastic (14 objects)
- Dung (14 objects)
- Other plastic (6 objects)
- Soil (13 objects)
- Green vegetation (5 objects)
- Dry vegetation (13 objects)

Dung/Dung Beetle	60.7%
All Plastic	39.3%



AR Meets Elephants



Summary and Conclusions

- Our climate is changing and causing loss of food security, displacing people and increasing wildlife-human conflicts.
- Critical need for **your research** on accurate, efficient and operational visualization of 2D/3D/4D information from imagery (*open access and online processing*).
- Call to action for the geospatial community to continue to help the Earth and her people.
- Trust your eyes/brain to understand imagery and interpret the success of your research results – then explore Machine/Deep Learning!

Acknowledgements

Elephant Group: Richard Fayer-Hosken, Andrea Presotto, William Langbauer, Malvern Karidozo, Ferrell Osborn, Michael LaGrange from Connected Conservation, Zimbabwe Victoria Falls Wildlife Trust, Zimbabwe US Forest Service Southern Research Station



National Park Service
Southeast Coastal
Network



Center for Teaching
and Learning
UNIVERSITY OF GEORGIA



UGA-CGR Assoc. Director Retired,
Dr. Tommy Jordan
UGA-CGR Graduate Students:
Drew Knight, Amanda Aragon



Thank You!

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