

Unmanned
Aircraft



SYSTEMS

UAS @ K-STATE

Mark Blanks

UAS Program Manager

July 2014

KANSAS STATE

UNIVERSITY

K-State Overview

- **Chartered in 1863**

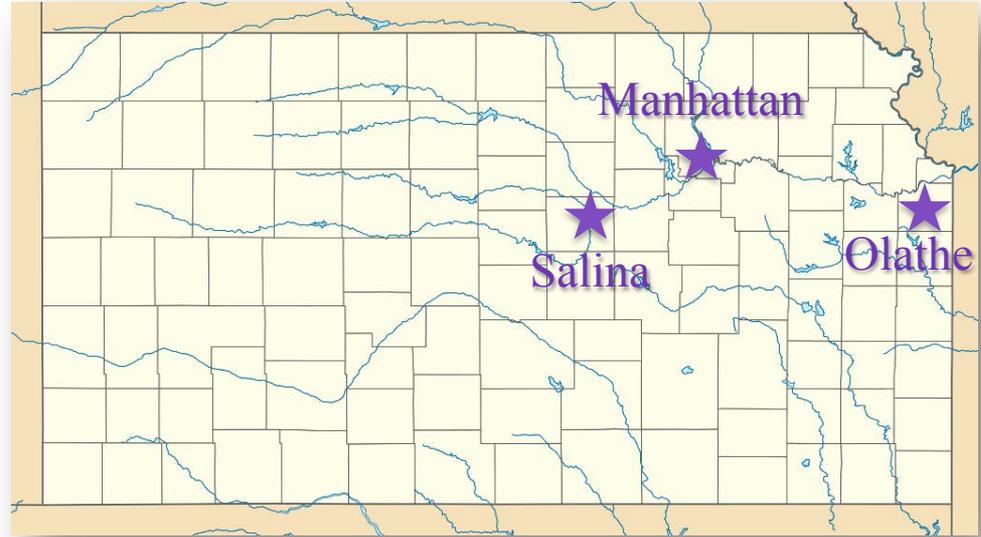
- Celebrating 150th anniversary

- **3 Campuses**

- Manhattan
 - Main campus
- Salina
 - Aviation and Engineering Technology
- Olathe
 - Graduate Studies

- **Facts:**

- ≈ 25,000 Students
- Land Grant institution



History of KSU UAS

- **2007**
 - Greensburg, KS Tornado
- **2008**
 - KSU UAS Program Formed
- **2009**
 - KSU UAS Tasked with UAS Disaster Response for Kansas
 - KSU Offers UAS Certificate
- **2011**
 - KSU Offers UAS Bachelor's Degree
- **2014**
 - KSU UAS Fleet Grows to 23 Aircraft



K-State UAS Fleet

- AAI Aerosonde Mark 4.7 Block D
- AAI Aerosonde Mark 4.7 Block E
 - Catapult System
- (2) UAV Factory Penguin B
 - Catapult System
- Aeryon Scout
- (2) UTC Aerospace Vireo
- (2) Viking Aerospace Wolverine III
- (2) KSU Crow
 - Catapult System
- (4) DJI S800 Hexacopter
- (3) 600-class Helicopter
- (2) Ritewing Zephyr
- (2) X8 Skywalker
- Hanger 9 "Ultra-Long-Stick"



Payloads

- **Current Payloads**

- Canon 6D NIR
- Canon S100 NIR
- Canon S100
- TetraCam ADC Micro
- FLIR Tau2 640 IR
- Sony Nex-7
- TASE Duo
- HD & SD Electro-Optical
- GoPro Hero3



- **In Progress:**

- Gamma & Neutron Detectors

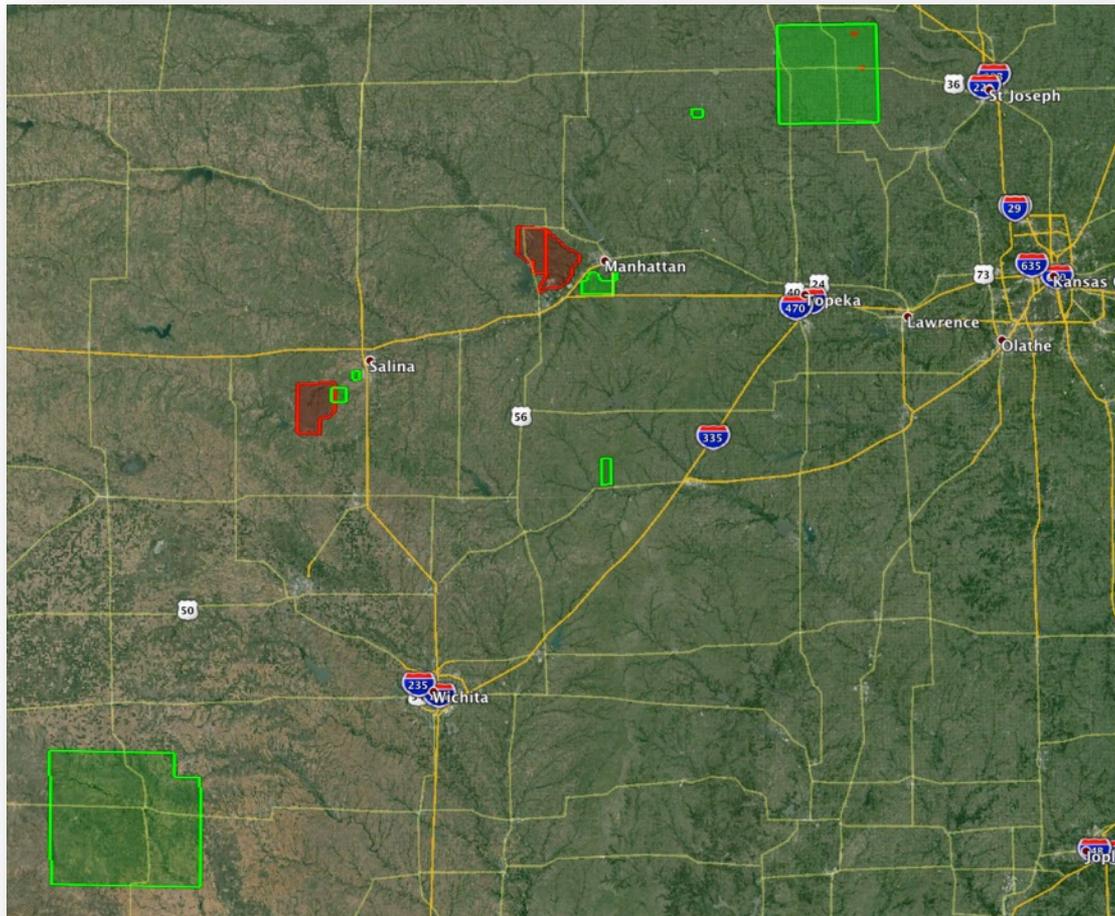


Flight Operations



KANSAS STATE
Unmanned Aircraft Systems

Operational Areas



- **2 restricted airspace operations areas for DoD-related research activities**
- **21 active COAs – 3 pending**

Research Program

- **UAS Research Program is Applications and Operations Focused**
 - Agriculture
 - Public Safety
 - Energy

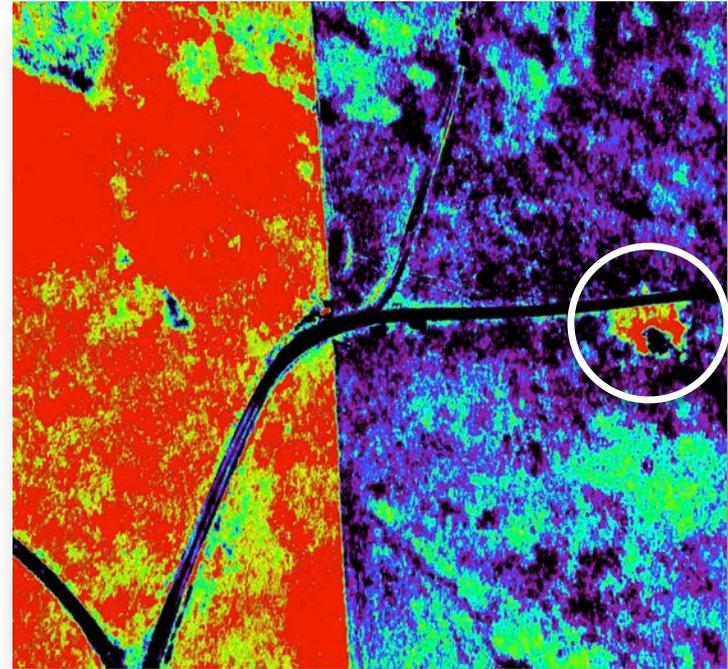
- **Researching Enabling Technologies**
 - Airworthiness
 - Aerial Mapping
 - Payloads
 - Operational and Performance Standards

SAMPLE RESEARCH PROJECTS

SPECIAL CREDIT TO DR. KEVIN PRICE AND DR. DEON VAN DER MERWE

K-STATE COLLEGES OF AGRICULTURE AND VETERINARY MEDICINE

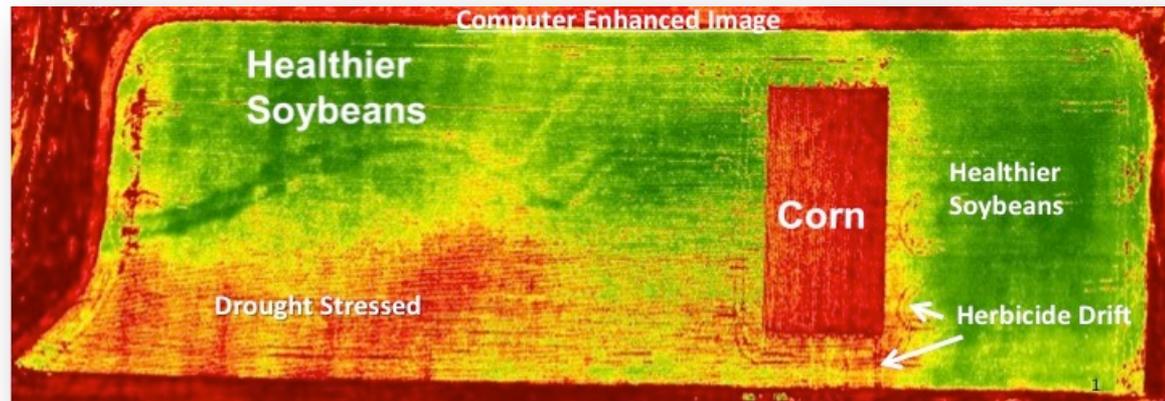
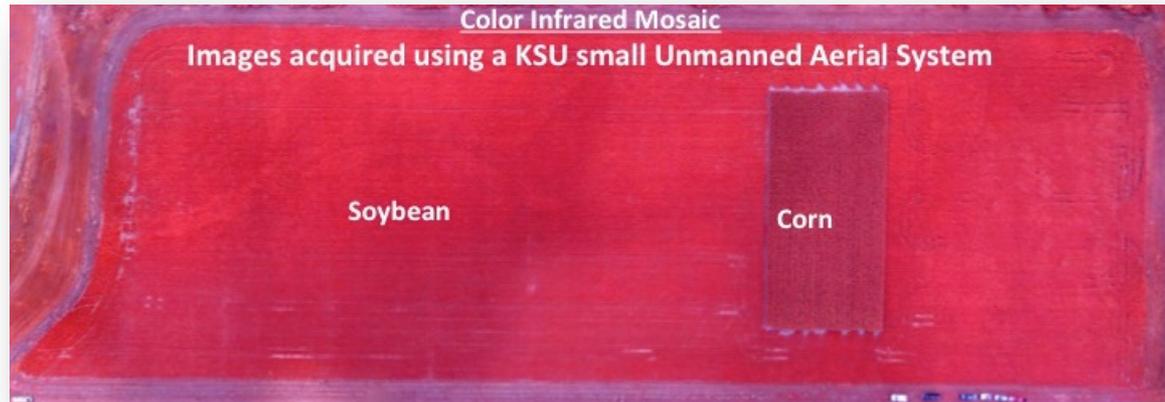
Ag – Rangeland Assessment



- **The amount of biomass produced each year by range and pasture lands greatly influences livestock and wildlife productivity and health**
- **Timely, accurate measurement of biomass productivity is critical to livestock, wildlife, and watershed management**

Ag – Crop Health

- **Assessing Crop Health**
 - Drought Stress
 - Insect Infestations
 - Diseases
- **Estimating Yields**
 - Greater Accuracy
 - Lower Cost to Assess
- **Characterizing Plant Phenotypes**
 - Reducing Labor Costs
 - Increasing Accuracy of Results



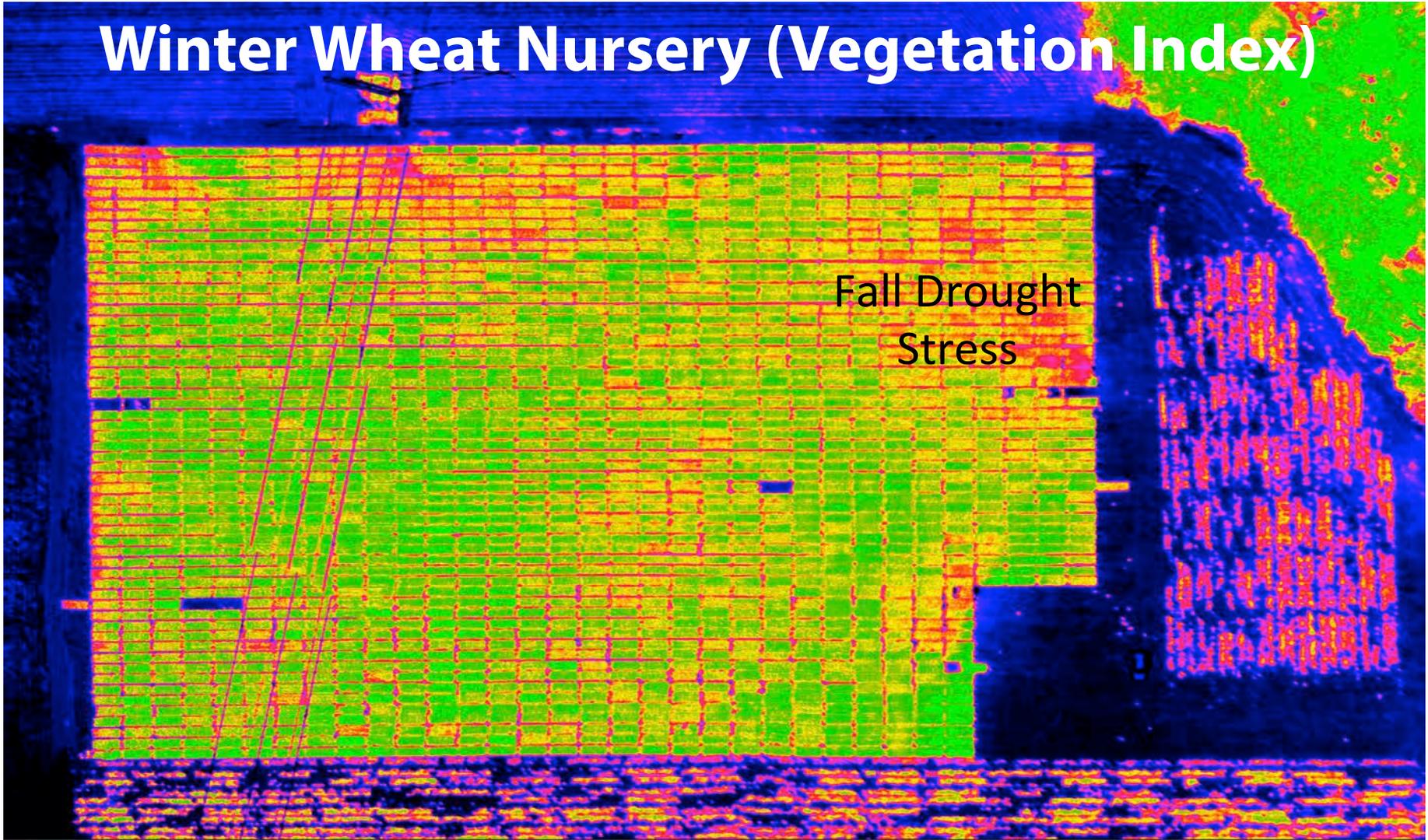
High Throughput Phenotyping

Winter Wheat Nursery



High Throughput Phenotyping

Winter Wheat Nursery (Vegetation Index)



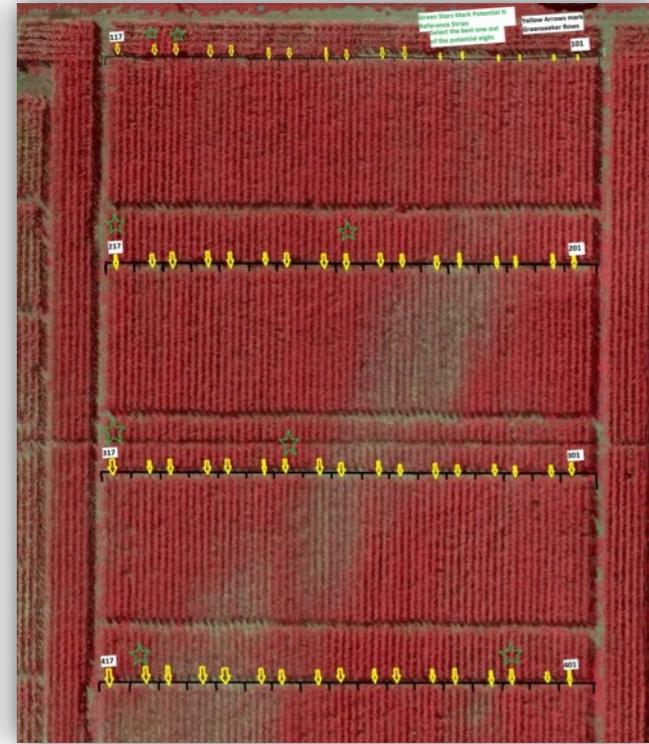
Comparing sUAS NDVI & GreenSeeker NDVI



Collecting color infrared imagery using hexacopter and Canon T4i NDVI camera



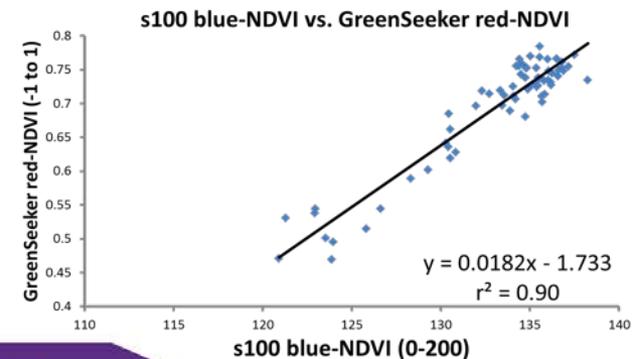
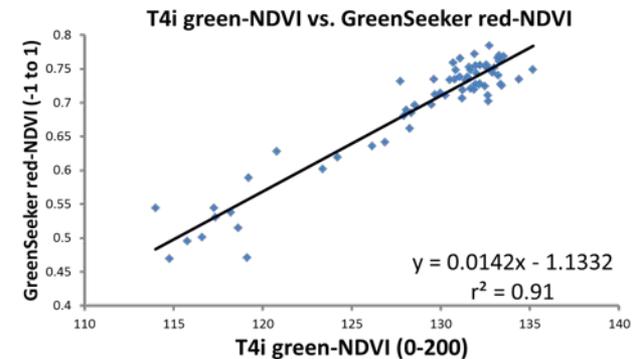
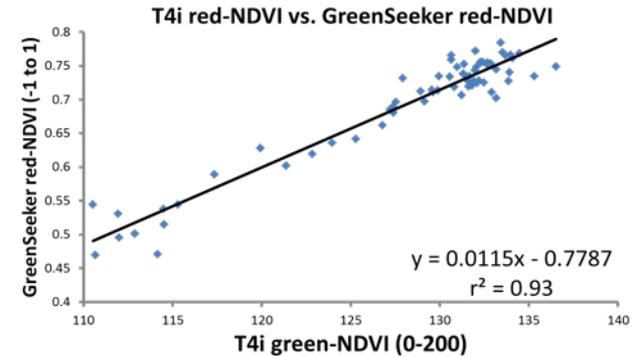
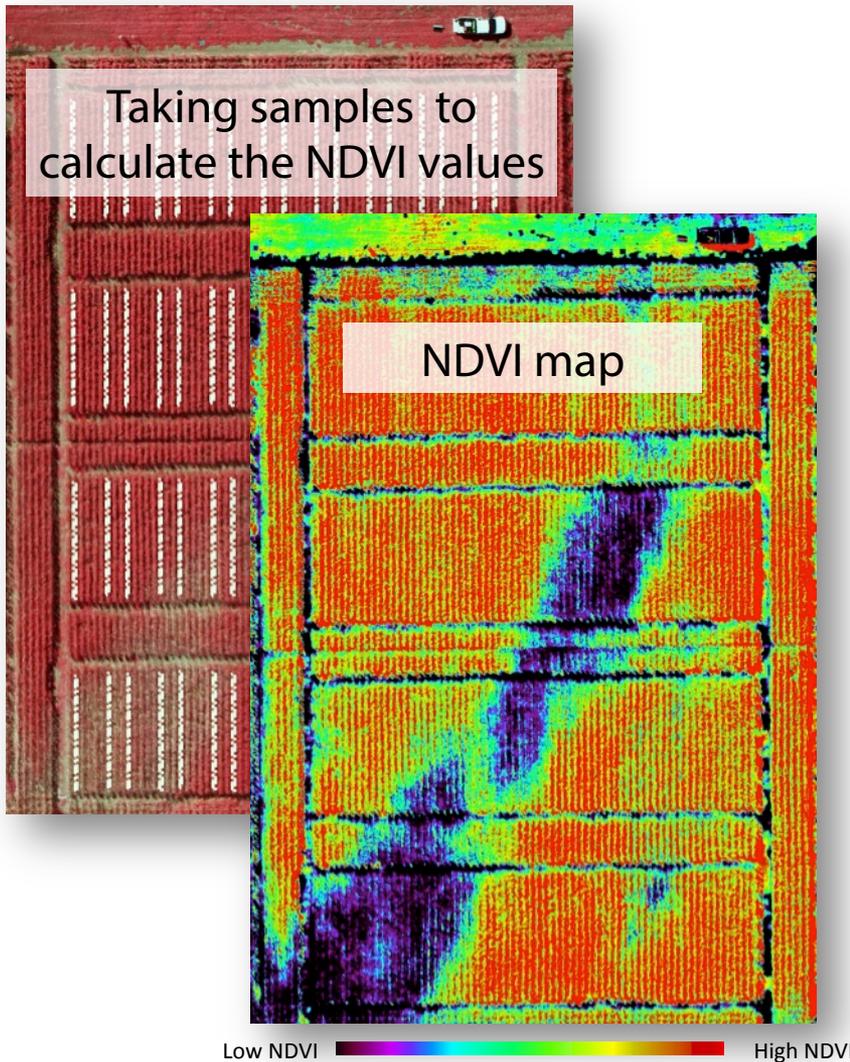
Collecting NDVI data using the Trimble® GreenSeeker® crop sensing system



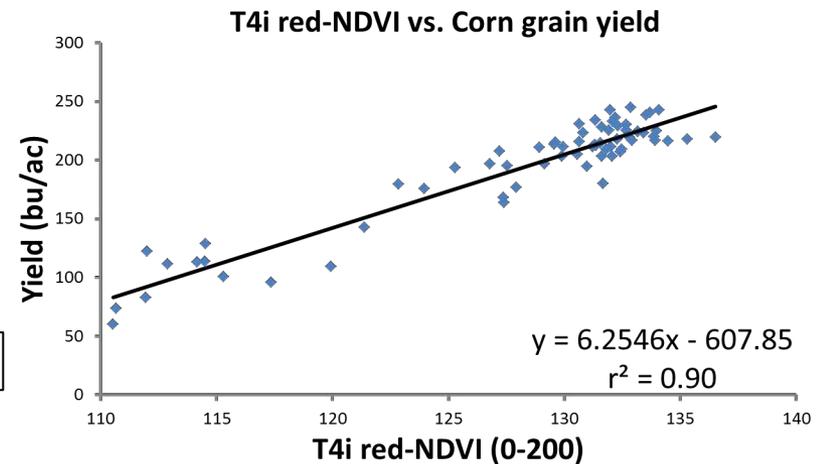
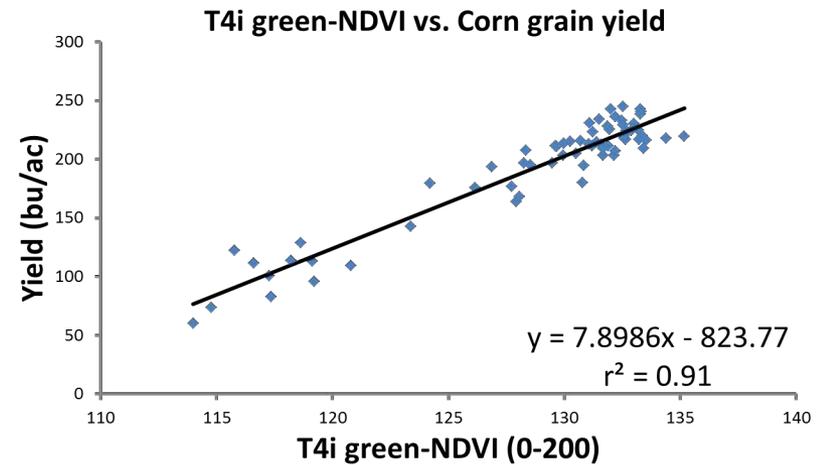
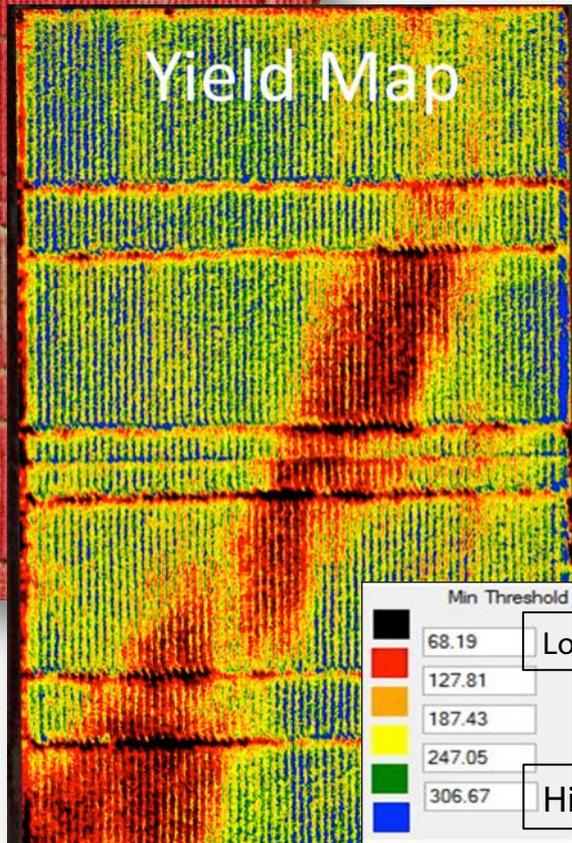
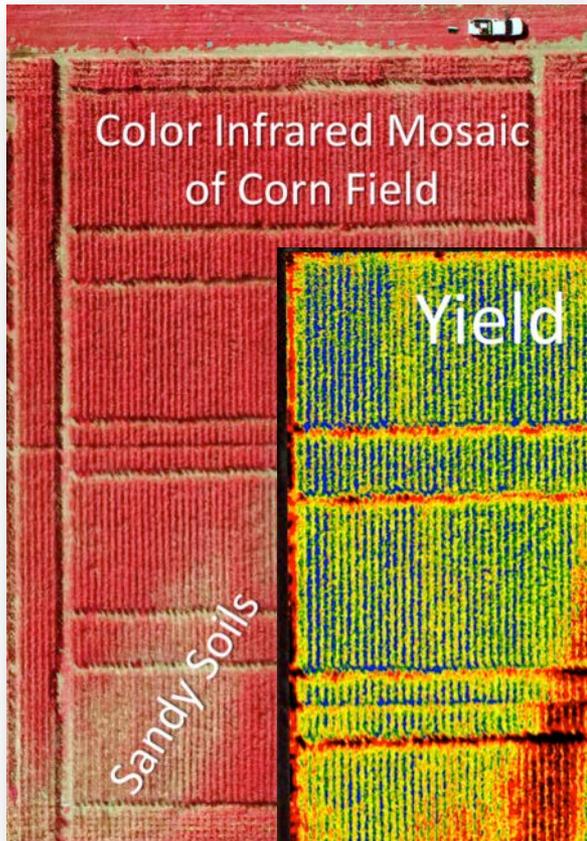
Yellow Arrows: GreenSeeker Row

Green Stars: N Reference Strips

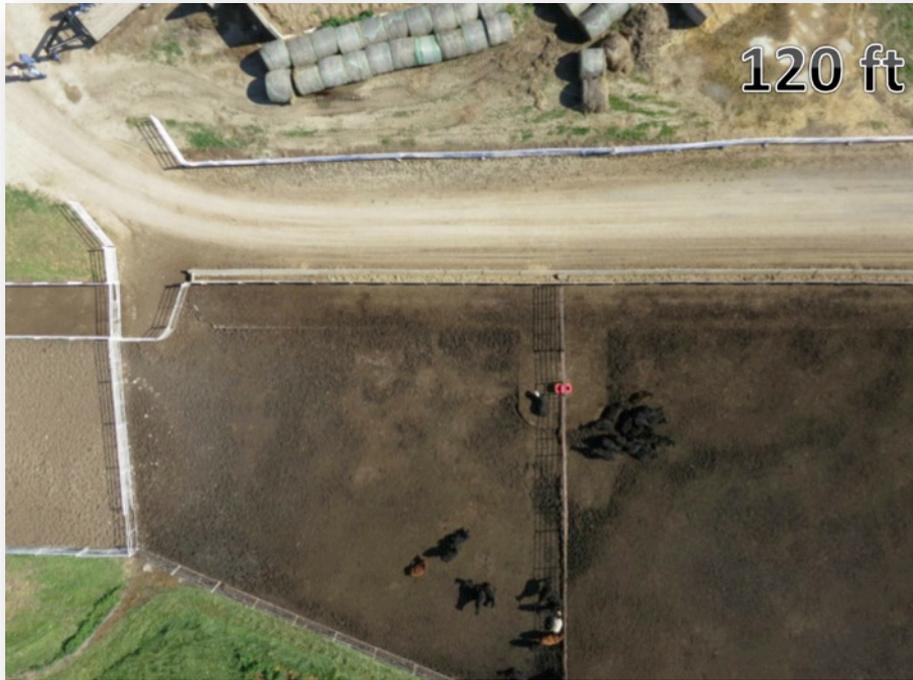
Comparing sUAS NDVI & GreenSeeker NDVI



Modeling Corn Yields

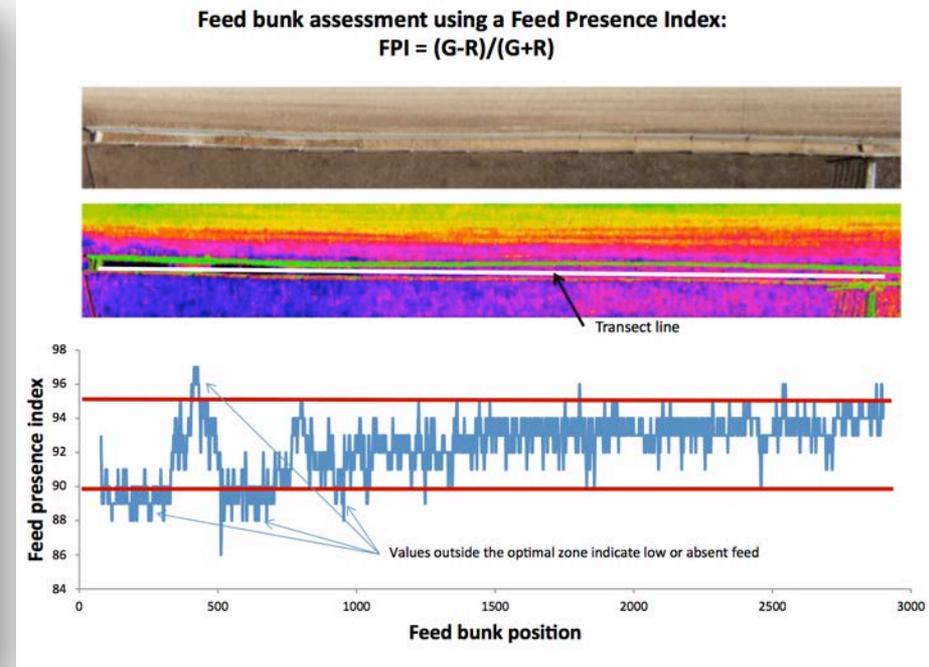


Feedlot Applications



- **Potential for monitoring number and distribution of cattle**
- **Can determine if the cattle have recently fed**
- **Thermal infrared imagery could identify relative temperature of cattle**

Feedlot Applications



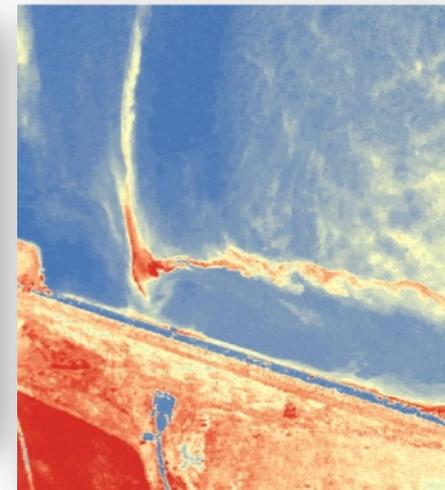
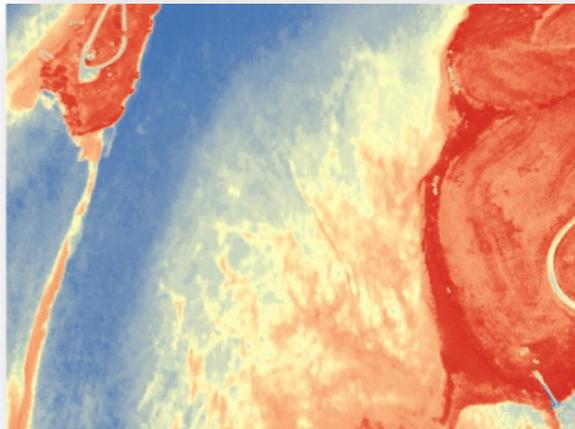
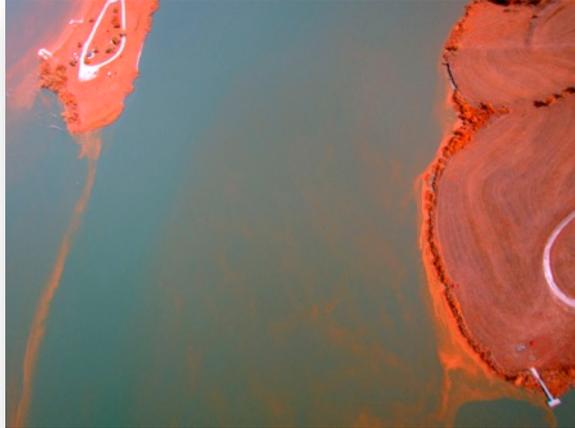
- **Feed bunks can be assessed for adequate quantity of feed**
- **Assessment perform using same technique as for crop health**
- **Real-time knowledge of feed bunk conditions could save time**

WATER QUALITY MANAGEMENT RESEARCH

SPECIAL CREDIT TO DR. DEON VAN DER MERWE
K-STATE COLLEGE OF VETERINARY MEDICINE

Harmful Algal Blooms

- **Harmful algal blooms degrade water quality, and toxins produced by algae can poison people and animals**
- **Traditional Sampling:**
 - High cost; long delay before results are available
 - Spatial and temporal variability = uncertainty
- **High Resolution remote sensing with UAS:**
 - Virtually complete surface sampling
 - Rapid results
 - Low cost



Harmful Algal Blooms (HAB) - Impacts

- **Adverse health effects**
 - Animals and people
 - Need to provide alternative water
- **Recreational access to affected waters may have to be restricted**
- **Expensive water treatment**



HAB Risk Characterization

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



Bad idea!!!!



Better

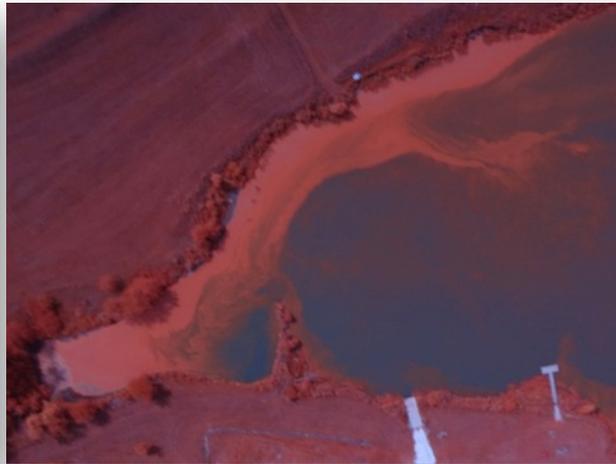


Best

HABs' Dynamic Nature



8/31/12



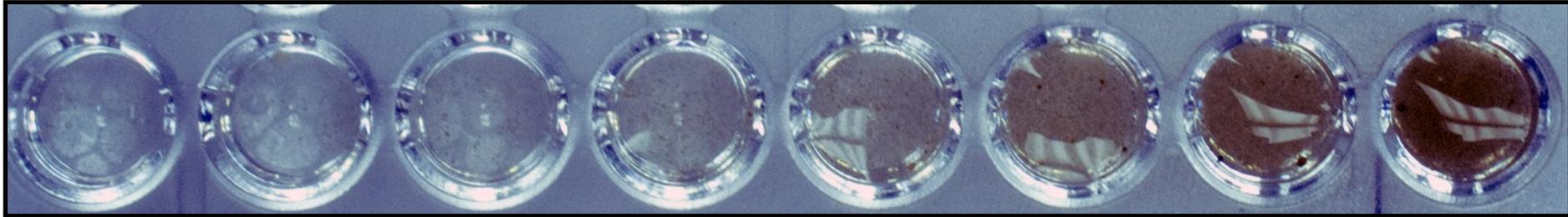
9/14/12



9/24/12

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

Modeling Blue-Green Algae Concentrations



Low Concentrations

High Concentrations

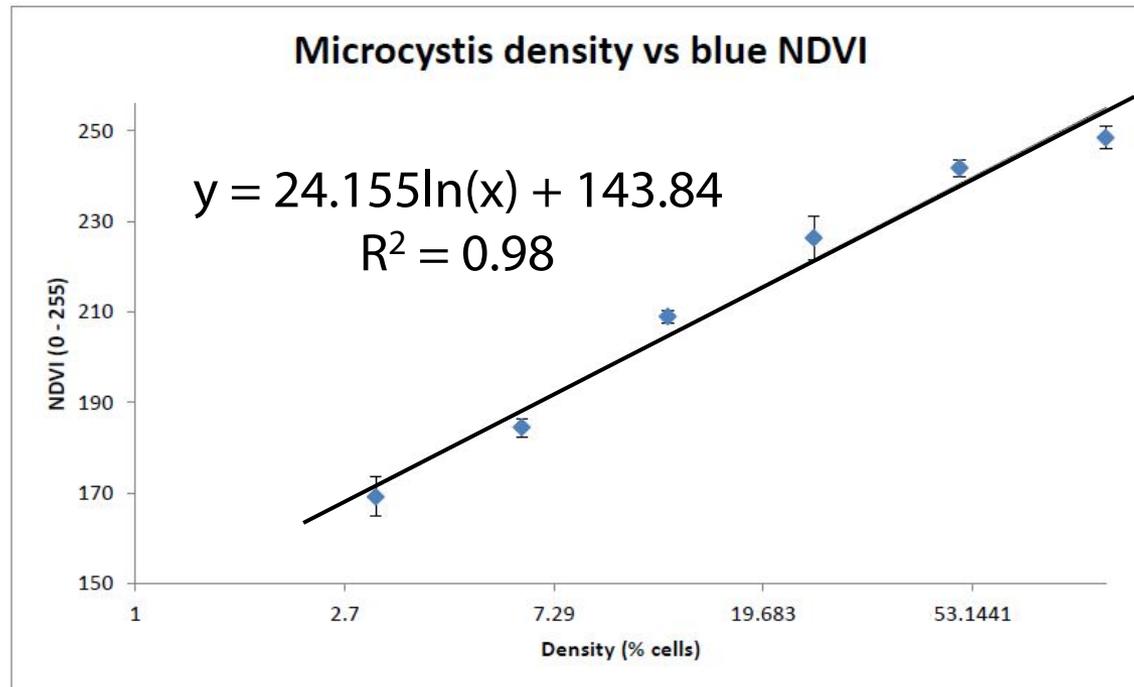
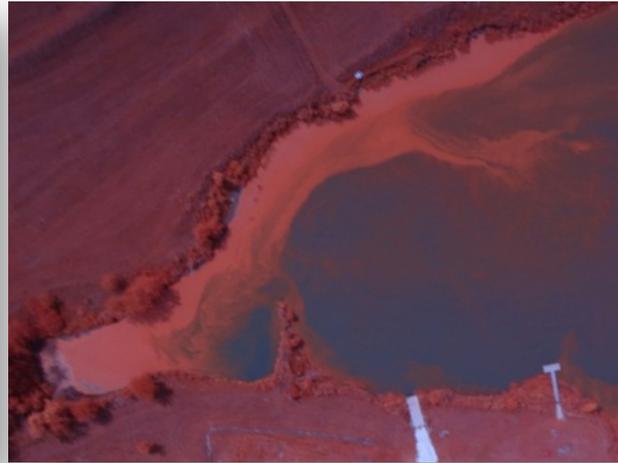


Image Acquisition



8/31/12

Visible



9/14/12

Color-infrared



9/24/12

Blue NDVI

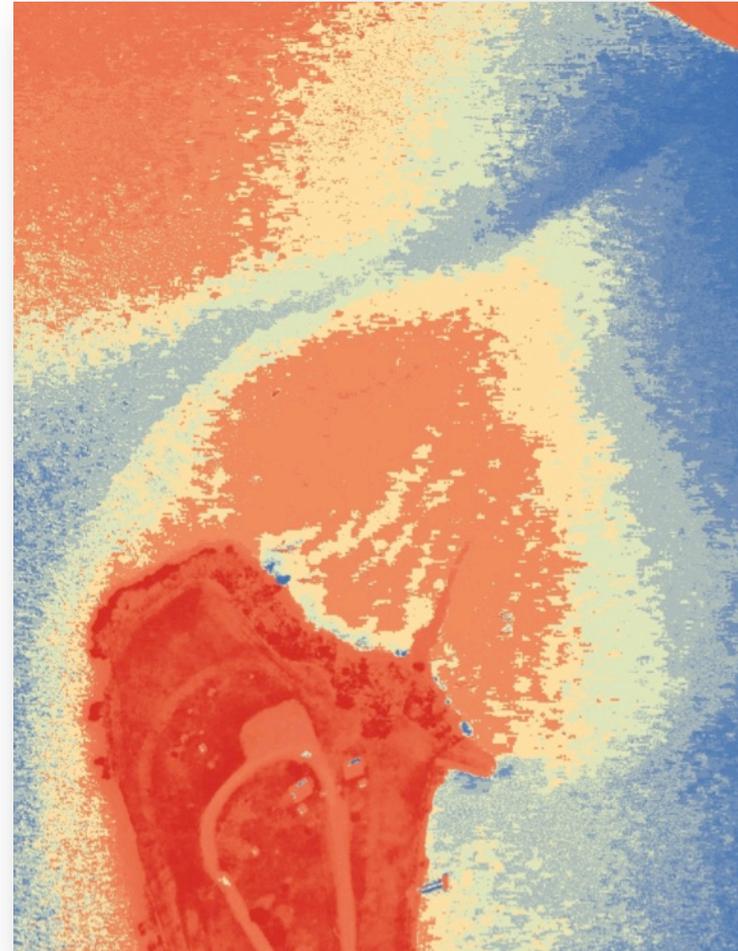


Applying a Vegetation Index to Quantify Differences in Algae Density

Color-IR



Blue NDVI



Livestock Pond Example

Normal image (red/green/blue)



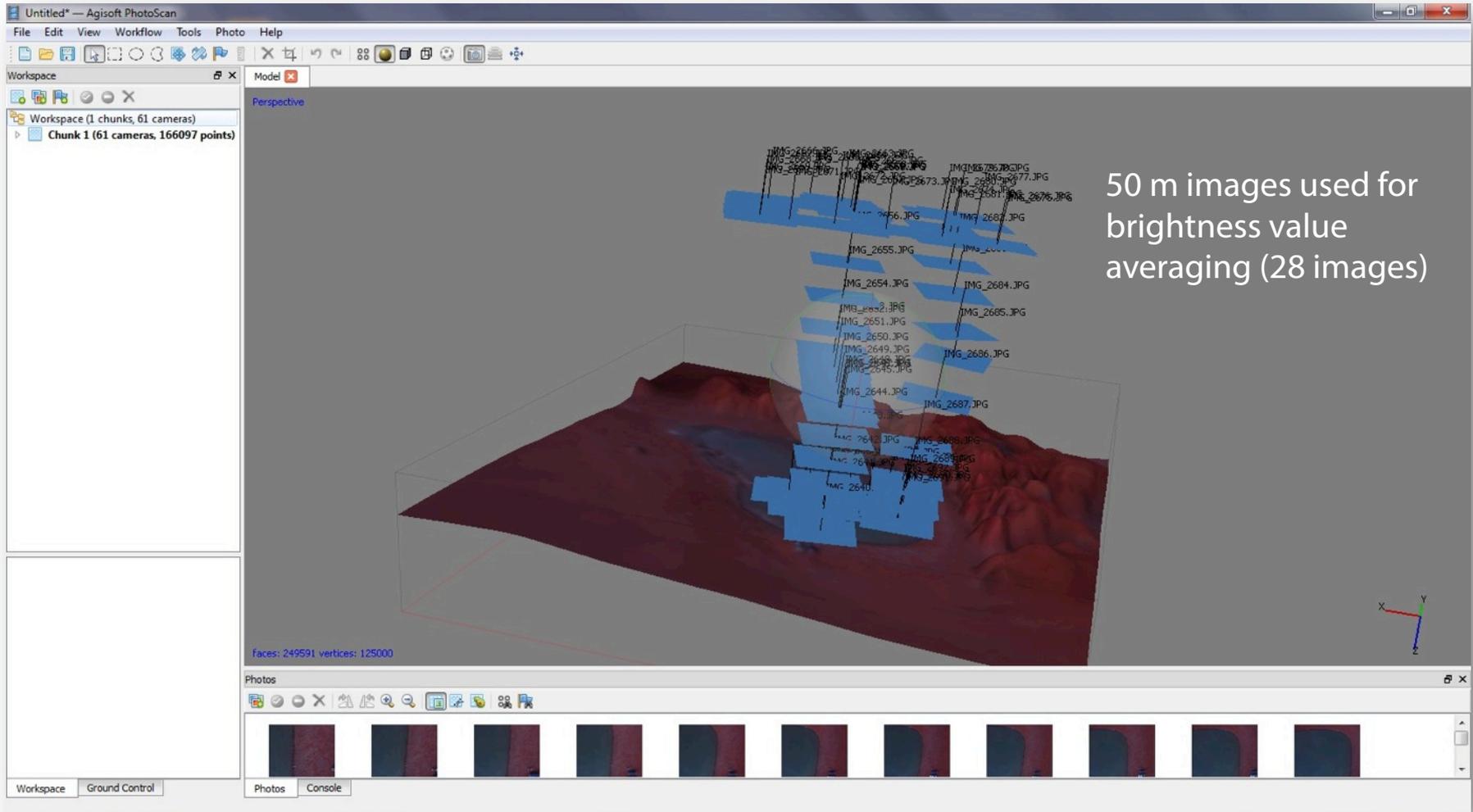
Calibration panel

Sample marker

Cloud reflections

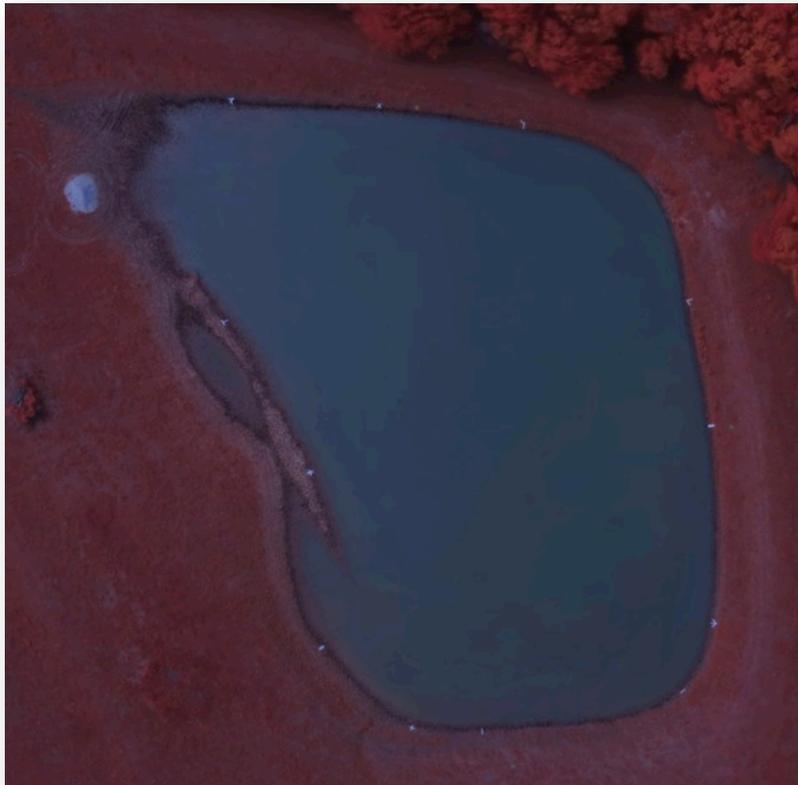
Note: No obvious algae gradient
Bright cloud reflections

Averaging with Agisoft Model

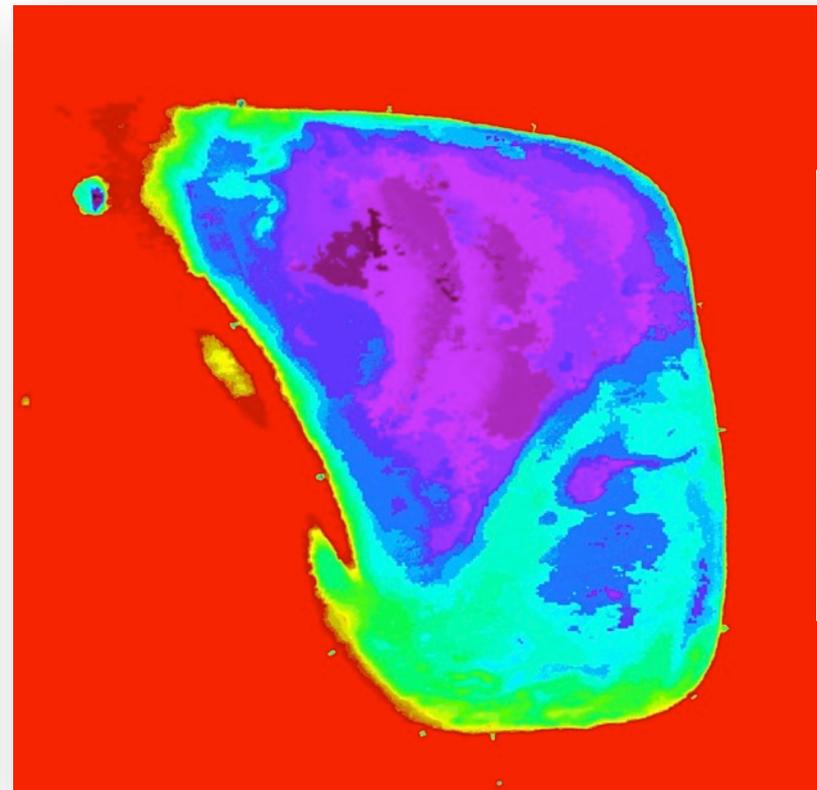


Averaged Orthophoto and NDVI

**Averaged color-infrared image
(NIR/green/blue)**



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



Note: Visible algae gradient
No cloud reflections

Traditional Sampling vs. Remote Sensing

- **Traditional sampling:**
 - High cost; long time
 - Spatial and temporal variability = UNCERTAINTY
- **High resolution remote sensing:**
 - Virtually complete surface water sampling
 - High efficiency

OTHER UAS RESEARCH @ K-STATE

Public Safety



- **Developing short courses for Public Safety**
- **Assisting public safety agencies in learning to operate UAS**
- **Utilizing Crisis City Training Center**
- **Working with Kansas First Responders and Beyond**

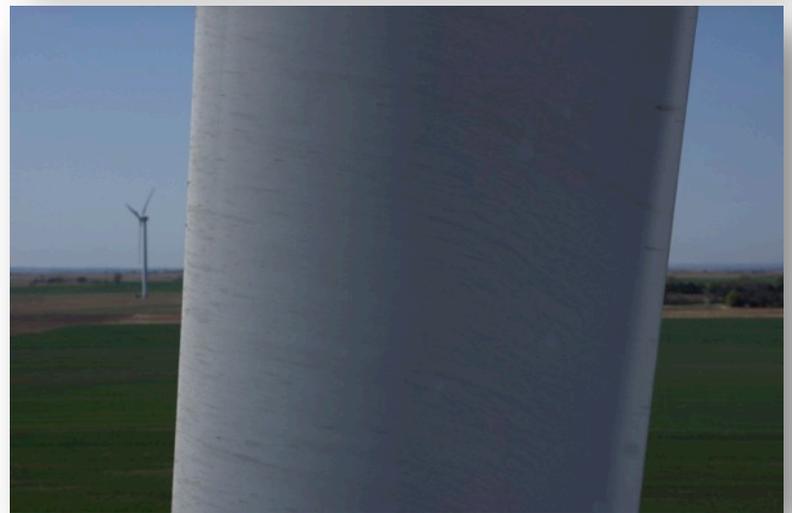
Energy

- **Wind**
- **Electric Power**
- **Pipeline**
- **Offshore**

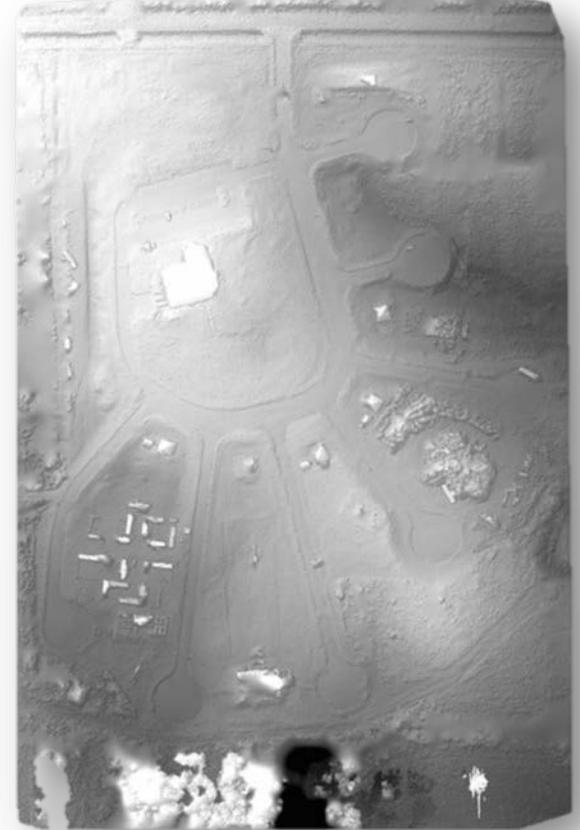
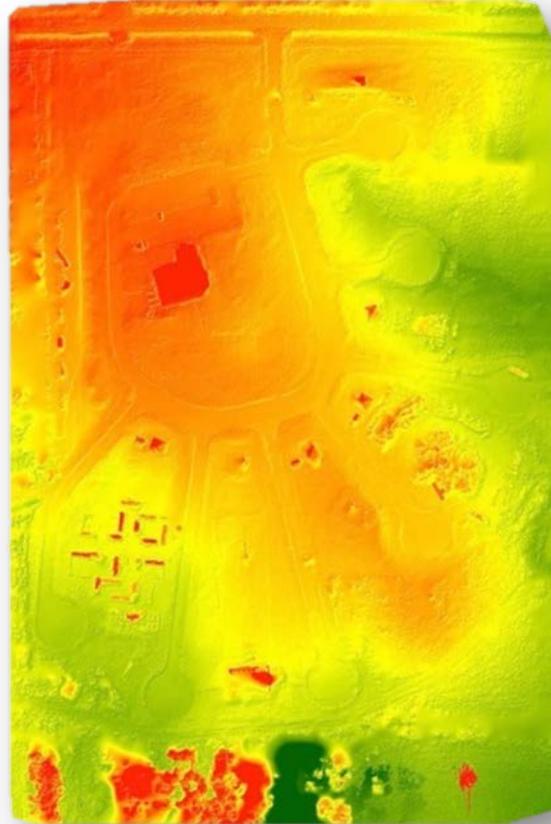


Vertical Plane Mapping and Measurement

- **Measurement on vertical surfaces crucial to infrastructure inspection**
- **Mapping of vertical surfaces would increase situational awareness**



Aerial Mapping



- **Crisis City Training Center – June 2013**
- **45 acres mapped @ 1.5 CM resolution**
- **Total mission time: 40 mins**

UAS Airworthiness

- **August 29th, 2013**
 - FAA and K-State sign MOA to “validate sUAS industry consensus standards”
- **What does it mean for a small UAS to be “airworthy”?**
- **Validating ASTM F38 standards by certifying a small UAS**



Contact Information

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UAS Video: <https://vimeo.com/51758864>

Aviation Video: <https://vimeo.com/57461648>

Aviation Promotional Video: <https://vimeo.com/47429682>